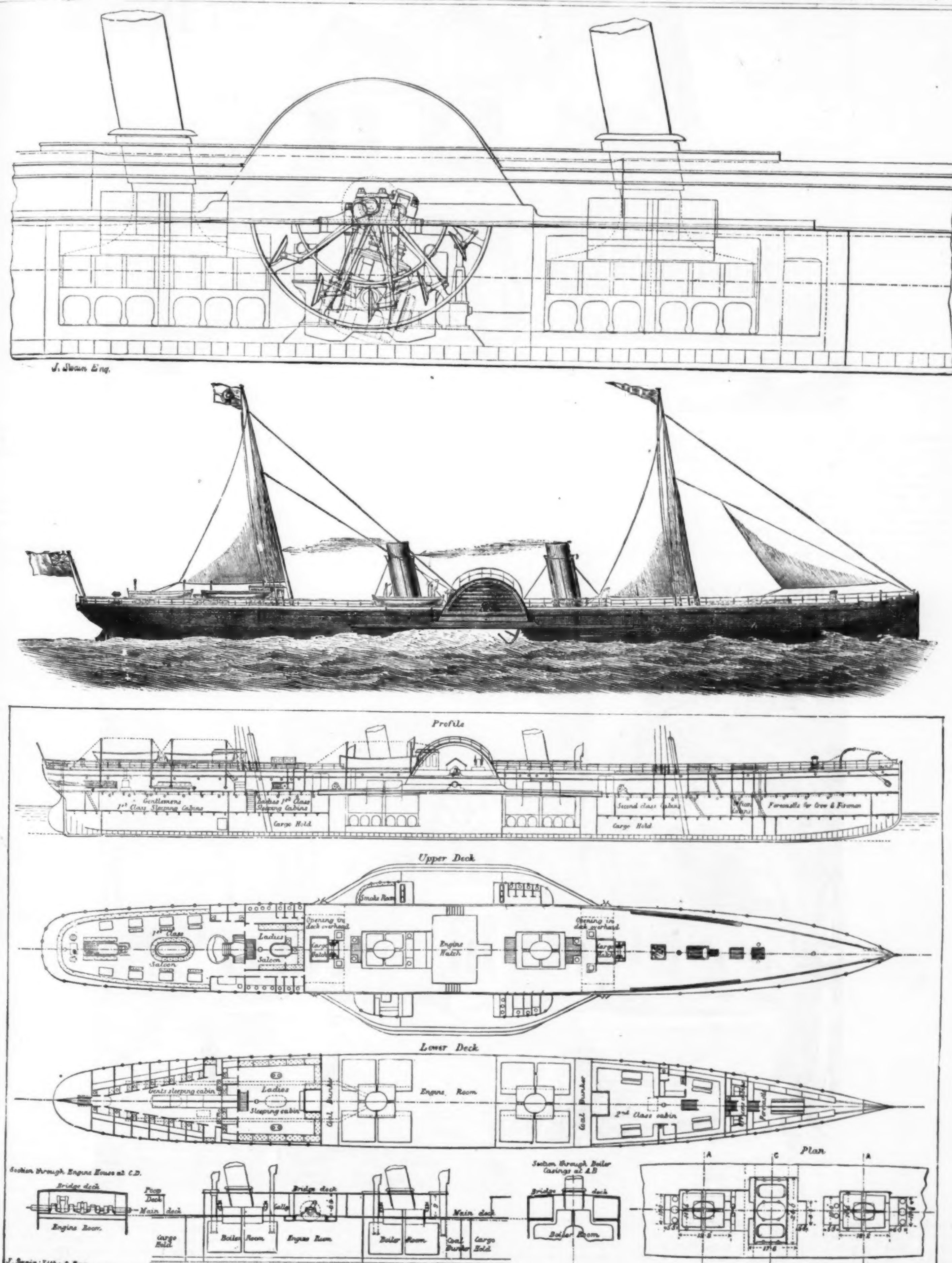
SCIENTIFIC AMERICAN SUPPLEMENT No. 386

Scientific American Supplement, Vol. XV., No. 386.
Scientific American, established 1845.

NEW YORK, MAY 26, 1883.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

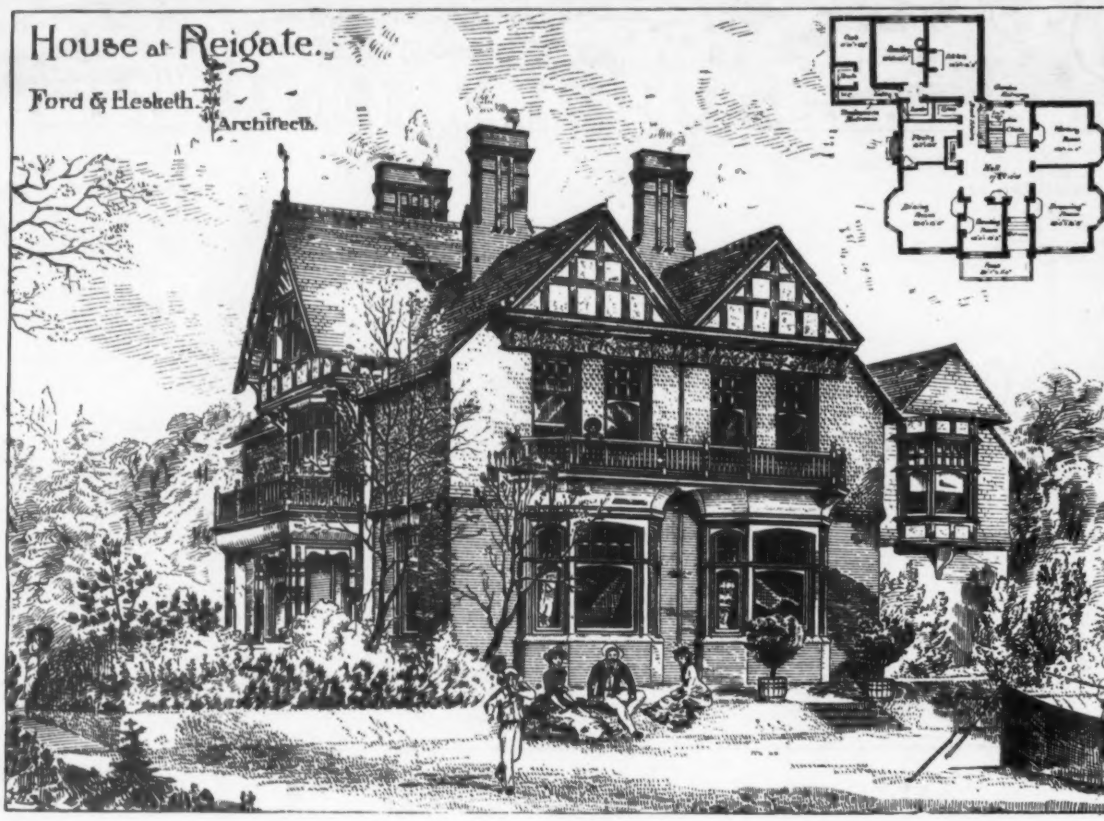


THE LONDON AND NORTH-WESTERN RAILWAY COMPANY'S STEAMSHIP VIOLET.

THE STEAMER VIOLET.

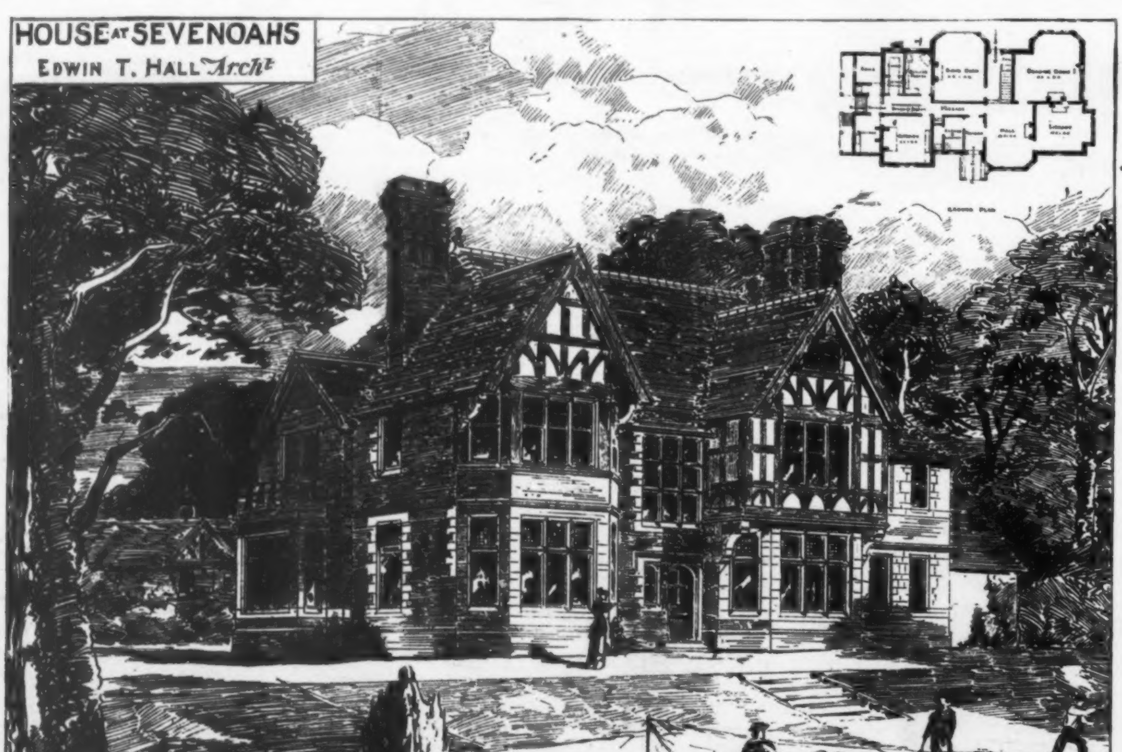
THE Violet and Lily are sisters, but the Violet is a little the faster of the two. She is 310 ft. long over all, 300 ft. 6 in. between perpendiculars, 33 ft. beam, and 14 ft. 4 in. deep. She is certified by the Board of Trade to carry 475 deck passengers and 417 saloon passengers. The fittings of the ship are admirable, and the second-class cabins present a marked contrast to the accommodation provided for second-class passengers on board the present mail boats, which is extremely bad.

The Lily and Violet are fitted with oscillating engines with jet condensers, and two diagonal air pumps, as shown on first page. The cylinders are 78 in. diameter and 7 ft. stroke, with double piston-rods and crossheads, the piston-rods being 8 in. diameter. The entablatures are of cast iron, and of box form, and are strongly supported by eight wrought iron columns, each 7 in. diameter. The crank shafts are 18 in. diameter. Each cylinder has two slide valves worked by a link motion in the usual way, and a combined steam and hydraulic starting gear is fitted which enables the engines to be reversed with great rapidity. The paddlewheels are 27 ft. 8 in. in diameter, the floats being 11 ft. wide and 4 ft. 6 in. deep. Steam is supplied by eight rectangular boilers, working at a pressure of 30 lb. per square inch. They contain 2,152 tubes, and have a total heating surface of 12,215 square feet, and a grate surface of 470 square feet. The mean indicated horse power developed on a continuous run of over three hours was 3,320 horse power, the revolutions being 30 per minute. The boats were built by Laird Bros., and are made of steel rolled at Crewe. These vessels ply between Kingstown and Holyhead.—*The Engineer.*



HOUSE AT REIGATE.

THIS house stands on a site near the highroad, about midway between the Red-hill and Reigate stations on the S. E. Railway. The walls up to first floor joists are faced with best red pressed Brockham bricks, and built with a $1\frac{1}{2}$ in. cavity, filled with cement, to form a vertical damp-course. The upper walls are tile-hung, and the roofs covered with red Broseley tiles, the gables being of timber, with plaster panels. The general disposition of the rooms is shown on the ground plan, the first floor being similar, with a landing of the same size as the hall below; and the attic floor contains two good bedrooms and a boxroom, with access into all roofs. The principal staircase is entirely of wainscot, wax-polished, as are also the floors of hall and parquetry-margins to floors of reception rooms. The large staircase window, the panels of entrance doors, and all upper lights of windows, are being filled with painted glass by Messrs. Campbell, Smith & Campbell; the fireplaces of hall and reception rooms are being fitted with patent ventilating grates by Mr. Boyd. The whole of the building works are being carried out in a satisfactory manner by Mr. E. Lawrance, of 16 Wharf Road, City Road, London, the contract sum being under £3,000. The architects are Messrs. Ford & Hesketh.—*Building News.*



HOUSE AT SEVENOAKS.

THIS house, now in course of erection at Sevenoaks Park for Mr. Charles N. Butler, is built of local gault bricks with hard red facings, all external walls being hollow. The whole of the ground floor windows and part of those on first floor have Bath-stone dressings. The "half-timbered" work is backed with bricks. The joinery of all principal rooms and the staircase is pitch-pine; the porch is of teak. The roof is covered with Broseley tiles. The work is being executed by a London builder, from the designs and under the superintendence of Mr. Edwin T. Hall, London.—*Building News.*

MANUFACTURE OF LEAD-CASED ELECTRIC CONDUCTORS.

AMONG those who have given careful attention to the question of producing cheap and effectively insulated electric conductors are MM. Berthoud, Borel & Co., of Paris. In these respects they have succeeded, and samples of their manufacture may be seen at the present electrical and gas exhibition at the Crystal Palace. M. Borel is the originator of this system of conductors, and his early experiments were directed to a cable with a conducting wire of lead or tin, arranged as shown in Fig. 1 of the engravings represented above.

In the figure, A is a lead or tin rod, and B is a leaden tube. The annular space between the two was filled with an insulating material, such as sulphur or resin. The structure thus formed could be drawn out to any desired degree of fineness, and would produce a conductor in which the initial proportions would be preserved, and the insulation was sufficiently good, the protective material not being destroyed even in bends of the conductors. With colophane as an insulator, it was found that a conductor on this system lost only $\frac{1}{10}$ of its electric charge in four hours, and that charged with static electricity it retained sufficient after ten days to affect the gold leaf of an electroscope. However, it was soon realized that this arrangement was impracticable, partly on account of the low conducting power of lead, and partly on account of the insulating material being reduced to dust, and thus brought into an unstable condition.

Working, however, still upon the same main principle, M. Borel in course of time succeeded in producing a conductor which, while widely different in its constructive details, has proved to be a practical success. Having perfected the invention, works were established by MM. Berthoud and Borel, at Grenelle, Paris, and Cortaillod (Canton de Neufchâtel, Switzerland). As at present manufactured, the conductor is formed of one or several copper wires covered with several thicknesses of cotton wrapped in opposite directions; that is to say, if the first covering is rolled from left to right, the second will be from right to left, and so on; in this manner the spaces between the wires are well closed. The first operation is effected by means of a special machine. The covered wire thus obtained is rolled on a reel and plunged into a bath containing a melted insulating material, which was formerly a mixture of paraffin and colophane, kept at a temperature of 392° Fahr., in order to remove the moisture from the cotton, and to make it penetrate the structure of the latter, to improve the insulation. A new compound, however, is now employed for insulation, containing no paraffin, and exposed during manufacture to a temperature of over 600° Fahr. The wire or wires thus protected are then incased in lead, a process frequently adopted before, especially to protect cables covered with gutta-percha from the destructive action of the air. The process of manufacture, however, is quite original, the general arrangement and details of the machinery employed at Cortaillod being shown at Figs. 2, 3, and 4 of our engravings. Fig. 2 is a perspective view showing the general arrangement of the apparatus, with its platform, from which the whole series of operations can be watched. A lead ingot is compressed by a hydraulic cylinder, formed into a tube, and drawn over the wire coated with the insulating compound. The lead ingot is placed in the chamber, P, which it fills completely; it has an axial hole equal in diameter to the exterior diameter of the tube, G. The piston, F, is forced upward by the hydraulic press placed below the apparatus; its diameter is equal to that of the ingot. The tube, G, is connected firmly to the piston, F, by cross pieces. At its lower end is a conical piece which determines the interior diameter of the envelope. The tube, G, which receives the conductor, is surmounted by the recipient, A, in which is a bath of melted insulating material, which is allowed to enter freely the interior of the tube by means of the opening, *h*. The stopper, *i*, serves solely for emptying the recipient when the operation is stopped. The vessel, B, is filled with hot oil supplied by the conduit. This hot oil maintains the temperature of the insulating material and preserves it in a liquid condition. From the recipient, B, it flows into the envelope, E, by a tube, and thus heats the lead chamber, flowing off by an opening. The chambers, C and D, are filled with coke dust or with some other bad conductor of heat.

In carrying out the process of manufacture, the wire, covered with cotton and rolled on its reel, is first plunged into the bath of insulating compound. It is then slowly unrolled and passes into the tube, G, where it receives a second charge of compound. The piston, F, forced upward, compresses the lead cylinder, which can escape only through the narrow annular space between the exterior part of the tube, G, and the diameter of the hole which traverses the piston. It is then drawn into a tube which exactly covers the cable. The apparatus is so arranged that the speed with which the cable is unrolled is equal to the speed with which the drawn lead flows from the compression chamber. The finished product passes over the small pulley, R, and is then rolled upon drums. The lead is heated to facilitate the operation of drawing. Experiments have shown that when cold it required a pressure of nearly 57,000 lb. per square inch, but that when raised to a temperature of 250° Fahr., it required only from 20,000 lb. to 40,000 lb., according to the thickness of tube produced. To facilitate placing the lead cylinder in the compression chamber, and changing the matrices required for different kinds of cable, the piston, F, can be turned on the bearings, T, so as to be placed horizontally on a bracket, as indicated in Fig. 4, by dotted lines. To replace the piston, a small wrench is used, which is attached to the apparatus.

The conductors thus made can only be used in the air. If it is intended to place them in the ground, certain precautions have to be taken to protect the lead from deterioration, and also to secure it from the attacks of certain boring insects. For underground work the cable, made as above described, is inclosed in a second casing of lead, and tar is forced in the space between the two. The speed with which this kind of conductor can be made varies with the type. A cable with three wires 0·5 mm. diameter within a lead envelope 4 mm. (0·16 inch) exterior diameter is completed at a speed of 50 feet a minute in regular working, though a maximum of nearly 150 feet can be made. There are many different types of this cable manufactured for telegraphic, telephonic, and other similar purposes, including electric lighting. Sectional views of some are shown at Fig. 5 of our engravings. They only differ in the diameter of the conductor and the thickness of insulating material. They are all protected in the same manner by an outer tube of lead separated from the inner by a thickness of tar. The cables for bell work, however, are not inclosed in an outer casing. In the first series, the inner lead tube has a standard thickness of 0·0295 inch; the outer tube is 0·4 inch; but these thicknesses can be varied at will. The length of cable produced in one piece is limited only by the size of the compression chamber of the machine. Where joints are required, they can be very easily made. The ends of the wires are bared, joined, and covered with cotton which is saturated with insulating material. A thin piece of lead is then wrapped around and soldered along its edge and at the ends to the inclosing tubes. The Swiss Government recently ordered for the central telephonic station at Berne a cable of nearly $1\frac{1}{4}$ inches in diameter, containing in its double lead casing 50 conductors of 1 millimeter each, single strand. The following is the classification of the sections made by this process and shown at Fig. 5:

No.								
1.	Telegraph	conductor,	7	cables of	7	wires of	0·5	mm.
2.	"	"	3	"	7	"	0·5	"
3.	"	"	1	"	7	"	0·5	"
4.	"	"	7	single	—	"	0·9	"
5.	"	"	3	"	—	"	0·9	"
6.	"	"	1	"	—	"	0·9	"
7.	Telephonic	"	2	"	—	"	0·7	"
8.	"	"	6	"	—	"	0·7	"
9.	"	"	14	"	—	"	0·7	"
10.	"	"	14	lines of	3	"	0·5	"
11.	"	"	2	"	3	"	0·5	"
12.	"	"	1	"	3	"	0·5	"
13.	Lighting cable		7	strands	—	"	1·14	"
14.	"		37	"	—	"	1·14	"
15.	"		12	"	—	"	1·14	"
16.	"		1	"	—	"	6·12	"
17.	Bellwork line		1	conductor				

In conclusion, we have only to observe that these conductors possess very high insulating properties, are capable of sustaining high temperatures without becoming impaired in efficiency, and are well spoken of.—*Iron.*

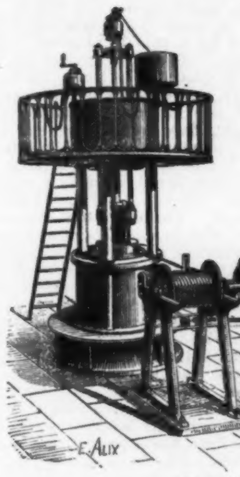


FIG. 2.

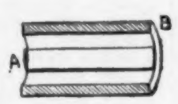


FIG. 1.

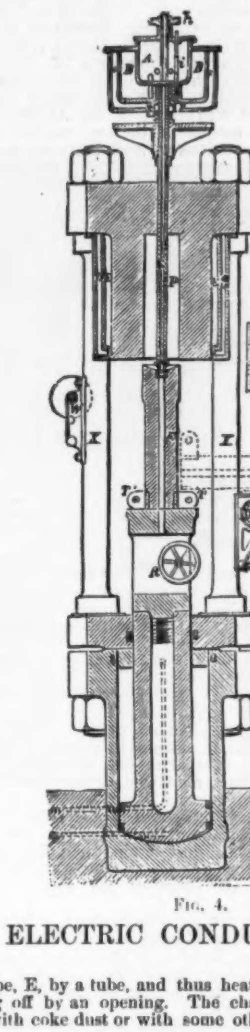


FIG. 4.

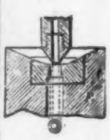


FIG. 3.

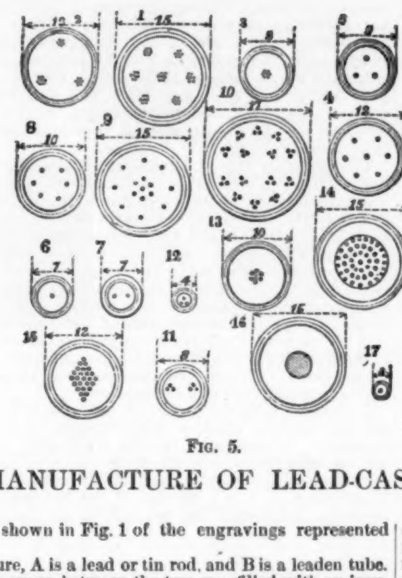


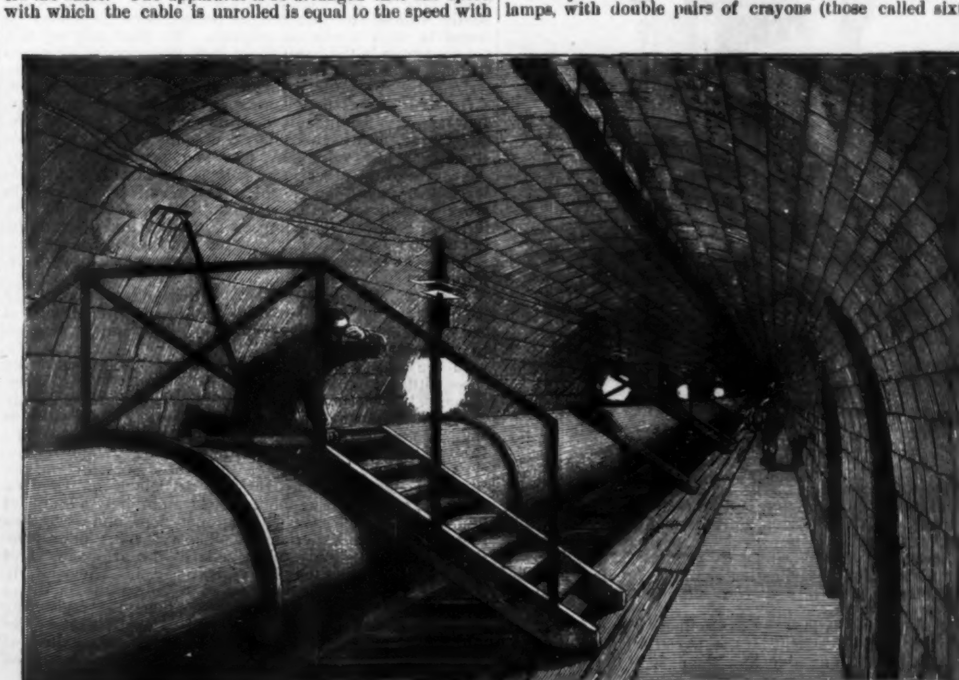
FIG. 5.

MANUFACTURE OF LEAD-CASED ELECTRIC CONDUCTORS.

THE ELECTRIC LIGHTING OF THE PARIS SEWERS.

THE municipal works of Clichy Levallois, a short time ago, lighted by electricity the great collecting sewer which daily distributes to the kitchen gardeners of the Gennevilliers Plain 80,000 meters of sewage. We reproduce herewith, from *Electricité*, a cut showing the general appearance of this brilliant subterranean illumination, which the recent inundations have unfortunately interrupted, but which the Municipal Council of Paris, we believe, will have the honor of continuing in order to keep that great city in the front line of progress.

The system adopted was the Brush, and consisted of six lamps, with double pairs of crayons (those called sixteen



THE ELECTRIC LIGHT IN THE PARIS SEWERS.

hour lamps), distributed on the same circuit and throughout a length of about 400 meters.

The lamps were supplied by a dynamo machine of the six foci type, which was placed in a building annexed to the works, in which are installed two motors, one of which is used to actuate a pump for forcing back sewage waters. The other pump was made to actuate the dynamo by means of an intermediate shafting.

The dynamo utilized a six horse motive-power, and made, on an average, 1,050 revolutions per minute. The current that it developed had an electromotive force of 300 volts, and an intensity of 10 amperes.

THE MAGNETIC STATION OF THE ST. MAUR PARK OBSERVATORY.

As well known, a magnetized needle capable of revolving freely around a vertical axis does not point exactly toward the north, but makes with the geographical meridian an angle called its *declination*. The vertical plane that passes through the line of the poles of the needle is the *magnetic meridian*. The declination is easterly or westerly according as the north pole of a magnet stands to the east or west of the geographical meridian. At Paris, the declination was easterly in the sixteenth century, the epoch to which date back the first observations on it. In 1666 the magnetic meridian was confounded with the astronomical, or in other words, the declination was null. Since then it has been westerly. Its maximum degree, 22° 34′, was observed in 1814 and 1815; but now it is no more than about 16° 23′. The mean annual decrease during this period has been 5·4′, and supposing that it continues in this proportion, the declination will become null again at Paris in about two centuries. But such a mean is far from being constant, so that it is impossible to determine accurately in regard to the matter.

Independently of this *secular variation*, the declination is submitted to a regular *diurnal* one. This latter is minimum toward 8 o'clock in the morning, and then increases progressively; that is to say, the north pole of the needle moves toward the west until one or two o'clock in the afternoon, and passes at night through an oscillation of less extent than the first. This double motion, more marked in summer than in winter, is, moreover, always comprised within very narrow limits. At Paris, the diurnal variation in the declination rarely exceeds 12′ to 15′. Finally, under certain special circumstances, and under the influence of causes that are as yet not well known, magnetized needles are submitted to accidental variations which are designated by the name of *magnetic storms* or *disturbances*.

FIG. 2.—DECLINOMETER.

When a magnetized needle is capable of turning freely around its center of gravity, it does not stand horizontally, but makes with the horizon a certain angle that is called its "dip." At Paris the north pole of the needle dips below the horizon at an angle which in 1671 was 75°, and now is about 65° 25′. The inclination or dip gradually diminishes in our regions, and is, moreover, submitted to periodic and accidental variations.

The secular variations in the declination and inclination are due to a displacement of the terrestrial magnetic axis. This axis is not immutable, like the axis of the world, and the magnetic poles seem to perform a rotary motion of extreme slowness around the geographical poles. In the last century the magnetic north pole was near Baffin's Bay, in the northeast of North America; but the position that most recent observations now assign to it is much more to the west, toward Melville Bay, in about 72° of latitude and 97° of west longitude. The magnetic south pole is nearer the geographical pole, its approximate co-ordinates being latitude 76° and east longitude 154°. Although observations have already extended through more than two centuries, the series is not yet sufficiently long to make it possible to deduce therefrom the duration of a complete rotation of the magnetic poles around the axis of the world.

Magnetic disturbances are intimately connected with the appearance of auroræ boreales, but no explanation has been made of the coincidences witnessed between terrestrial magnetism and certain phenomena; for example, between the extent of the daily oscillation of the magnetic needle and the frequency of sun-spots; and the question as to whether magnetic storms have an influence over our great atmospheric disturbances remains still in the state of hypothesis. Our knowledge is very imperfect as to the causes and place of origin of those mysterious forces that sometimes act over the two hemispheres of the globe simultaneously, as was seen on the seventeenth of last November. It was principally with a view to fill such a gap in our knowledge that, on a proposition presented to the Meteorological Congress of Rome by Lieutenant Weyprecht of the Austrian navy, the different maritime nations of the two continents sent, last year, scientific expeditions to high latitudes, that is to say, to regions where magnetic disturbances acquire the most intensity. The data thus collected during one year, according to a general plan, will be compared with observations made simultaneously in stationary observatories. It is to be hoped that a discussion of these data will shed some light upon this so interesting and as yet so obscure a part of the physics of the globe.

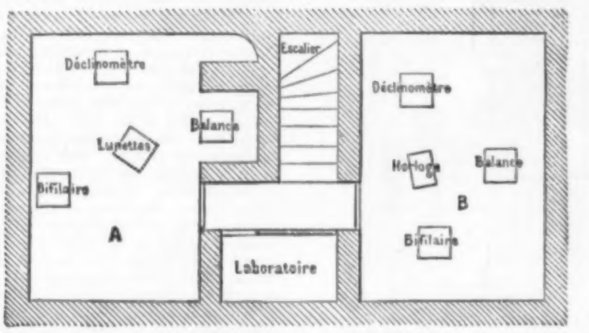


FIG. 1.—PLAN OF THE CELLARS.

The work of a magnetic observatory consists in the observation of the *direction* and *intensity* of terrestrial magnetic force. The direction of this latter is defined by the declination and inclination; and, to measure its intensity, it is usually resolved into two components—one horizontal and the other vertical. There exist, moreover, between the different magnetic elements, relations such that it is only necessary to know three of them (among which is declination) in order to deduce therefrom the value of the others. In practice the observation is limited to the declination, the inclination, and the horizontal component; and hence three distinct compasses, according to the purposes for which they are designed.

In order to measure the absolute declination in a place, we first have to determine the geographical meridian, and then the direction that is taken by the magnetic axis of a magnet movable around a vertical axis. Dipping needles should, then, permit of determining the geographical and magnetic meridians. They are, in fact, true theodolites provided with special pieces for magnetism. Theodolite compasses of recent construction possess, besides, different accessories for the absolute measurement of the horizontal component.

The dipping needle consists essentially of a magnetic needle movable around a horizontal axis passing through its center of gravity.

When such axis is perpendicular to the magnetic meridian, the angle of the needle with the horizon gives the dip. We cannot, in this place, give the methods employed to determine the absolute value of the magnetic elements, and a description of the compasses used for such measurements would lead us too far; but the principles of them may be found in such works on physics. We shall only say that the apparatus in the Saint Maur Park Observatory were constructed by Messrs. Brunner with all that care that characterizes the apparatus furnished by these skillful workmen.

Observations of these compasses take a pretty long time, and it would be difficult to repeat them with sufficient frequency to follow in their daily course the different magnetic elements, whose value may, moreover, possibly vary during the course of the observation. It is found sufficient to observe them from time to time, every week, for example, in order to determine the constants, and to control the operation of the variation compasses, these being the true instruments for current observations, and the ones whose indications are systematically noted at fixed epochs, every hour, for example.

We shall limit ourselves to a summary description of the magnetic station, originated last summer by Mr. Mascart at the Saint Maur Park Observatory, which is under the direction of Mr. Renou.

In the midst of a vast wooded estate, of an area of six acres, situated on the Marne far from all disturbing influences, the Central office has had constructed, for the study of terrestrial magnetism, a special cottage of dimensions as small as possible—7 meters in length by 5 in width—and the front of which is directed according to the geographical meridian (Fig. 5). This cottage, into whose construction and furniture there enters not the least particle of iron, and no magnetic substance, forms in its elevation, only a beautiful hall, which occupies the whole ground floor, and serves as a room for various experiments. The apparatus for observations are installed in arched cellars, the arrangement of which is shown in the plan view in Fig. 1. The westerly cellar (A) is specially appropriated to apparatus for direct reading, and the easterly one (B) contains the registering apparatus. Facing the stair case there is a laboratory for photographic manipulations. Air vents formed in three of the walls secure sufficient aeration to keep the apparatus from all dampness.

The degree of magnetization of the magnets varies notably under the influence of temperature, and it is for the purpose of reducing, as much as possible, sources of error resulting from sudden changes in this that the apparatus have to be placed in an environment where such variations are slight. Cellars, provided that they are dry and well aired, very fittingly realize this important condition.

The variation apparatus are three in number: the *declinometer*, the *bifilar*, and the *magnetic balance*. These are invariably fixed upon masonry pillars, whose minimum distance apart is about 2 meters, it having been found by experiment that at such a distance the magnetized bars employed have no action upon one another. A general view of the apparatus in position is given in Fig. 4. The declinometer, D, serves, as its name indicates, to measure variations in declination; it is shown in detail in Fig. 2. A circular metallic case, B, 10 centimeters in height and 8 in external diameter, supported by a tripod, provided with leveling screws, carries along in its motion around the vertical axis a graduated circle, C, placed at its base. Its front contains a circular aperture, O, into which is set a converging lens of a focal distance of one meter. A metallic column, V, 17 centimeters in height, fixed by its lower end to a second graduated circle, C′, terminates at its other extremity in an arbor, T, to which is attached the thread from which the bar is suspended. This thread is simply a cocoon fiber 20 centimeters in length. The bar, A, of square section, is only 4 centimeters in length. The hooks that support it carry a plane mirror parallel with its axis. The other vertical mirror, M′, is set into a fixed frame which forms part of the case. A rod, R, provided with a carriage that receives a deviating magnet, serves to determine, when required, the absolute value of the horizontal component by the deviation method. Two other pieces make the apparatus complete: (1) a spy-glass, L (Fig. 4), provided with a hair-cross, and mounted on an adjustable standard; and (2) an ivory scale, E, divided into demi-millimeters, and likewise mounted on an adjustable standard. These different apparatus are regulated and arranged in such a way that on disposing a source of light (for example, a small reflecting lamp, or even a candle) properly in front of the scale, the images of the divisions are reflected from the mirrors into the spy-glass. On putting the eye to the eye-piece, two images are seen, one of which, produced by the fixed mirror, serves as a datum point, and the other, produced by the movable mirror, follows all the motions of the bar and gives the variation expressed in divisions of the scale. The angular value of one of the divisions has previously been determined by revolving the declinometer-case to an angle of a few degrees, measured very exactly upon the circle, C, and by observing the relative change in the two images of the scale. One division of the scale is equal here to an angle of 2′, and, as a tenth of a division is easily estimated by the eye, it results that the declination may be known with an approximation of 0·2′ or of 12 seconds of an arc.

The bifilar, B (Fig. 4), is designed for measuring the variations in the horizontal component of the terrestrial force. The external form of this apparatus is like that of the declinometer. It, likewise, is provided with two mirrors, with a divided scale, E′, and with a crossed-hair spy-glass, L′. The only difference consists in the mode of suspension, and the direction of the bar. The magnet is suspended from two silk threads, which are held apart to a distance of about 5 millimeters, by means of two notches in the supporting hooks. A special arrangement of the suspension arbor, T (Fig. 2), permits of varying the distance apart of the threads at their upper part, so as to give the apparatus the desired sensitiveness. Finally, the case contains an aperture into which passes the rod of a thermometer.

To observe with the apparatus, the arbor is revolved until the bar takes a position perpendicular to the magnetic meridian. In this state, the bar is attracted by two equal and opposite forces—one due to the action of the earth, and the other to the torsion of the bifilar system. This latter being constant, it is clear that if the horizontal force increases or diminishes, the bar will, in one direction or the other, undergo deviations whose extent it will only suffice to observe upon the scale. Special experiments, of which we shall speak at the proper time, and corrections that we can merely indicate here, permit of the conversion of the deviations observed into a fraction of the horizontal force. The sensitiveness of the bifilar in operation at the Park is such that one deviation corresponds to $\frac{1}{5000}$ of the horizontal component; and, as a tenth of a division is easily estimated, the approximation is $\frac{1}{50000}$.

FIG. 3.—MAGNETIC BALANCE.

The magnetic balance serves to measure variations in the vertical component. This apparatus is represented in detail in Fig. 3. It consists of a magnetic needle, A, provided with a knife-edge, C, which rests upon an agate. A nut, movable on the rod, T, permits of bringing the magnet into a horizontal position. A second nut, E, movable on a ver-

tical rod, permits of raising or lowering the center of gravity so as to regulate the sensitiveness of the needle, which latter may be raised at will, like the beam of a pair of scales, by means of a forked piece controlled by a screw, V. Like the preceding apparatus, the balance is provided with two mirrors, which are here arranged horizontally and the edge of which is seen at M, with a divided scale, E'' (Fig. 4), and with a crossed-hair spy-glass, L''. It is inclosed in a small case whose top, over the mirrors, contains an aperture on which is mounted a rectangular isosceles prism, P, one of whose sides is slightly convex, so as to make it at the same time a converging lens one meter in focal length. The luminous rays refracted by the prism and reflected by the mirrors are sent horizontally into the spy-glass, and the readings are made absolutely as in the declinometer and the bifilar. A second aperture, O, is designed for receiving a thermometer, which is read at each observation. Finally, in order that the surfaces of the prism may be kept free from dust, and that the bar be kept from the influence of dampness, the entire apparatus is, in addition, covered with a large glass case which contains potash desiccators. The fraction of the vertical component which corresponds to one division of the graduated scale is determined by experiment.

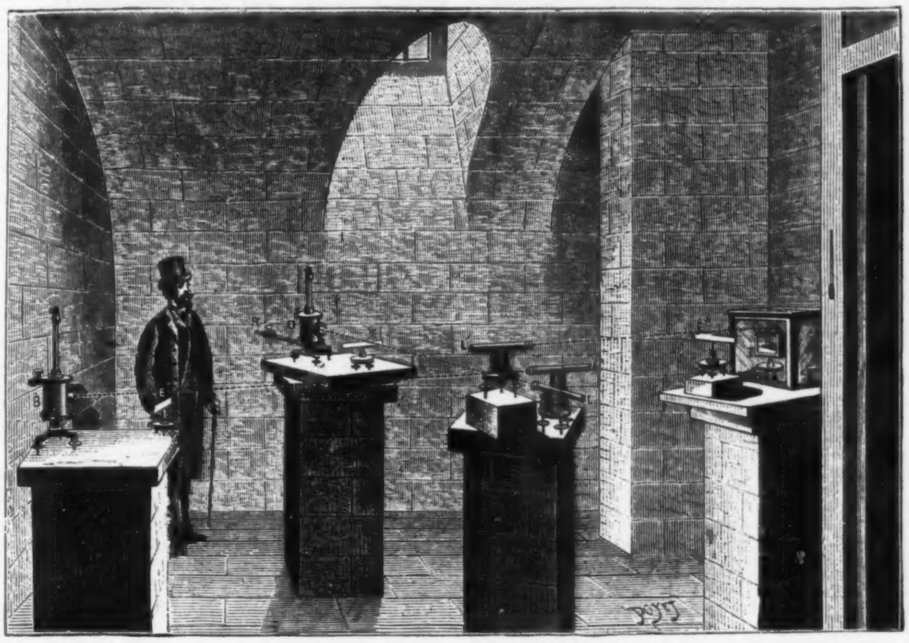


FIG. 4.—GENERAL VIEW OF THE APPARATUS IN POSITION.

The Park balance is so regulated that a deviation of one division shall correspond to $\frac{1}{5000}$ of the component, and the approximation may reach $\frac{1}{50000}$.

The variations in inclination and in the total force are deduced from observations of the bifilar and the balance.

The quantities to be measured are always very small, at least when the phenomena go on regularly, and so the magnetic observations are extremely delicate. In order to be exact, they necessitate the use of apparatus of extreme accuracy.

It will be at once seen that this installation would suffice for a magnetic observatory, were it possible to limit one's self to the noting of variations in the magnetic elements at definite moments. But there occur, especially in winter, important deviations in the interval between two hourly observations, and the disturbances that terrestrial currents cause in the regularity of the phenomena show how insufficient, under certain circumstances, that direct observations are made by the irregular motions of the compasses. On the 24th of last February, for example, the declination varied 36' between 9 hours 10 minutes and 9 hours 20 minutes in the evening. Efforts have therefore been directed for some time toward finding a means of performing the registering automatically. In a succeeding article we shall complete this paper by a description of Mr. Mascart's registering magnetograph, which also is in operation at the Saint Maur Park Observatory.—*Th. Moureaux, in La Nature.*

PORTLAND CEMENT: ITS MANUFACTURE AND USES.*

By REGINALD E. MIDDLETON.

THE use of Portland cement in the construction of buildings and public works is extending so rapidly, and it is so superior to all other known cements, that I believe some short account of its manufacture and employment will be interesting to the members of this society, and I therefore venture to lay before you the following remarks, which do not pretend to go beyond my own experience of the material, or to describe the manufacture as carried on abroad, but only to give a short description of the practice on the banks of the Thames and Medway, with some account of the difficulties met with and of the ways in which the material may be employed. Most valuable papers have been read before the Institution of Civil Engineers by Messrs. Scott and Redgrave, Bernays, and Grant on this subject; and there are books by Messrs. Reid and Faija, treating of the same matter, and I fear that I can offer you nothing new which you cannot read about elsewhere; but I may be able to put some points before you in a new light, and you may, I trust, learn something from my remarks, and more from the discussion to which I hope they will give rise.

Without any further preface, or apology for asking you for your attention, I will proceed with my paper. Portland cement is a comparatively new material, having been accidentally discovered in 1824, and it was not until long after this time that its manufacture at all approached in uniformity or strength the cement of the present day. The name of Portland cement is taken from a real or supposed resemblance to Portland stone. The materials used in the manufacture of Portland cement are white or gray chalk and mud, and the fuel employed is gas coke and coal. The process of manufacture may be divided as follows:

1. Getting the chalk and clay.
2. Mixing the chalk and clay in certain proportions, and producing slurry, as it is called.
3. Drying the slurry.
4. Burning the slurry into clinker.
5. Crushing the clinker.
6. Grinding the crushed clinker, and thus producing the finished cement.

The analyses of the materials are in general terms as follows:

WHITE CHALK FOUND ON THE BANKS OF THE THAMES.

Water	25·000
Silica	0·455
Alumina	0·639
Carbonate or lime	73·755

GREAT CHALK FROM THE MEDWAY.

Water	25·00
Silica	4·09
Alumina	2·12
Carbonate of lime	66·44
Oxide of iron	0·79
Soda and alkalies	1·96

MUD FROM THE MEDWAY.

Water	60·00
Organic matter	2·14
Silica	27·82
Alumina	4·96
Oxide of iron	3·60
Carbonate of lime	1·00
Alkalies	0·76

These analyses are obtained from the works of Messrs. Faija and Reid.

The analysis of the mixture of chalk and clay used in the manufacture of Portland cement will then be somewhat as follows, varying according to the quality of the materials and the amount of water present in them, and the temperature of the atmosphere:

Water	35·00
Organic matter	0·61
Silica	8·35
Alumina	1·87
Oxide of iron	1·02
Carbonate of lime	52·97
Alkalies	0·21

From the above analysis we find that, taking the average of all weather, 35 per cent. of water present in the chalk and clay has to be got rid of.

According to the old system of manufacture, the chalk and clay in certain proportions, namely, about 25 of chalk to 1 of clay, and with the addition of about 300 per cent. of water, are filled into the washmill, the most common form of construction of which is a circular brick tank about 12 feet diameter, and 4 feet deep, in the center whereof revolves a vertical shaft carrying four or more horizontal arms from which depend cast iron frames, carrying steel harrow tines, which stir up the mixture until it is reduced to particles which will pass through a gauze sieve having 24 meshes to the lineal inch. After passing through the sieves, the slurry is pumped into channels, which deliver it into large backs or reservoirs, the bottoms of which are formed by the natural ground or by chalk filling, and should preferably be pervious and easily drained; here the particles are allowed to settle by gravitation, and the supernatant water is drawn off by means of penstocks until the slurry is thick enough to be dug out. This process occupies from 4 to 7 weeks, and the specific gravity of the particles not being the same, their tendency is to settle in layers, and this must be counteracted by constant stirring or luting. Heavy storms of rain seriously affect the time of consolidation, which is at best long. When the slip or slurry is sufficiently consolidated, it is dug out and wheeled on to the drying floors, where the remaining moisture is removed by heat. The time occupied by the process of settlement in backs being so long and the result being uncertain, and the amount manipulated at one time being large, and therefore any error in its composition a serious matter, it has been the object of cement manufacturers to shorten the process of mixing and drying, and with this end in view Mr. Gorham patented a process in which the same washmill is used, but without the gauze strainers, and with the addition of water to the extent of only 12 per cent., so that the resulting slurry is in a state of thick paste, or not containing much more water than when, in the other process, it is dug out of the settling backs. When mixed, the slurry is lifted by means of an elevator or otherwise to a pair of burrstones and then ground, after which it is dried as before. The logical sequence of this arrangement is that patented by Mr. V. De Michele, in which a similar washmill is used, and about the same amount of water is added to the materials to be mixed, but the grinding process is carried on simultaneously with the washing by means of two cast iron plates about 9 inches broad, one of which is fixed to the edge of the trough of the washmill and the other rotates with, and at the same speed as the arms which carry the harrows. The slurry having been mixed in the mill and passed between the grinding surfaces of the cast iron plates, is collected in a sump and passed, either by gravitation or pumping or otherwise, on to the drying floors.

The usual form of drying floor is a coke oven 8 feet wide by 45 feet long or thereabouts, covered where the greatest heat strikes with tiles of fireclay 3 inches thick, and along the flues with cast-iron plates 1 inch thick. For economical working just sufficient slurry should be washed on to the floor to be dried in 24 hours or a little less, so that the slurry washed one morning may be quite ready for removal the next morning. The quantity of coal required to dry sufficient slurry to make one ton of cement is about 6 cwt., and each oven should produce from a charge of 8 cwt. of coal 3 cwt. of coke, which is used for burning in the kilns.

As the consumption of fuel is a large item in the cost of manufacturing cement, and as the repairs of these ovens, from the burning and buckling of plates, and from displacement caused by expansion, amount to a heavy charge, the attention of manufacturers has been directed to utilizing the spent heat from the kilns for the purpose of drying the slurry, so that each kiln in burning may dry a charge of slurry for itself. To this end the kiln is arched over, and from the level of the top of the kiln a platform of concrete is carried of the width of the kiln and of sufficient length to dry the required quantity of slurry, this length depending on the system of drying employed. Mr. T. C. Johnson arches over this platform with a brick arch having about 6 feet rise, and the slurry is pumped on to the concrete floor, and the spent heat from the kiln, passing over it on its way to the chimney, dries it, and when dry and the kiln drawn

* A paper read before the Civil and Mechanical Engineers' Society, Dec. 21, 1882.

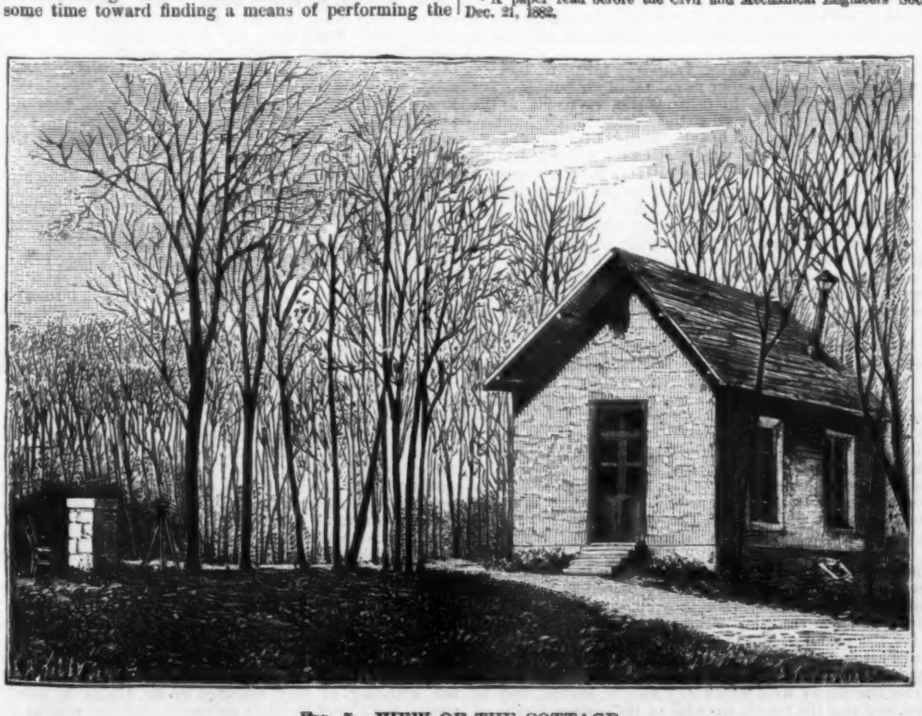


FIG. 5.—VIEW OF THE COTTAGE.

and clear, it is shoveled, along with a certain proportion of coke, into the kiln. In order that they may work to the best advantage, the arches of these chambers should be made thick on the tops, and spandrels should be filled in with cinders or other non-conducting materials. Mr. V. De Michele used an arch with about 4 feet rise, and dries the slurry not only on the concrete floor inside the chamber, but also on the top of the arch, which should in this case be made as thin as is compatible with safety. In other arrangements the cover of the chamber is flat and made of concrete or firebricks in an iron frame, so that it is movable, and the slurry can be got at and removed when dry, the flues or chambers in this case being of small depth, or narrow flues are used with cast iron plates, as in the coke oven. It is obvious that there is a considerable saving to be made in fuel by any of these arrangements; but, on the other hand, the first cost is much heavier, as the floors must be made on a level with the top of the kiln, and it is only in a very few situations where this advantage can be gained without considerable extra cost, and a very large chimney is required. The charge for pumping is heavier, both on account of the great length of the pipes and the extra height to which the slurry must be forced; and the slurry being very thick, the pipes are liable to be choked and stopped, especially in frosty weather; and the kilns do not burn off so quickly as is the case with the open topped or bottle kiln; and thus there is a large outlay on all sides for a less production, though at a cheaper rate in working also; whereas the ovens are always drying slurry, the chambers are only working about half their time, and so a certain amount of capital is lying idle. It is stated by the advocates of this system that the cost of manufacture is considerably reduced by its use, and under favorable conditions, that is to say, when the foundation is good, and especially where the chamber can be constructed on a bench of chalk or other firm basis at, or nearly at, the level of the tops of the kilns, I have no doubt that such is the case; but when the circumstances are unfavorable, it is, I believe, an open question which arrangement should be adopted.

The kilns used with the drying ovens are those known as bottle kilns, and vary in capacity from 13 to 30 tons each of finished cement; they are circular in plan, with square drawing eye about 3 feet 6 inches across, and are loaded through openings in the sides and in the dome which covers the kiln. The dried slurry is put into the kiln along with a certain proportion of gas coke, about 8 cwt. to the ton of cement, and the whole is fired by means of a few fagots laid on the furnace bars in the drawing eye. Small kilns of a capacity of 15 tons of finished cement may be got, that is to say, loaded, burnt, and drawn, about once in from three to four days; but the larger kilns, of 25 tons capacity and upward, especially when worked in connection with chambers, can seldom be got more frequently than once in from seven to eight days; from this it appears that the smaller kilns are more advantageous than the large kilns, as 30 tons can be got from the small kilns in the same or shorter time than 25 tons from the large kilns; but, on the other hand, it must be remembered that as the smaller kiln is loaded and burnt off twice while the larger one is only burnt off once, the lining of the former will suffer more than that of the latter, and it will sooner require repairs, though, again, the cost of relining is smaller in the case of the 15-ton kiln than in that of the kiln with a capacity of 25 tons; but as kilns are very unequally burnt, it is impossible to say what would be the comparative cost in each case.

Chamber kilns are sometimes built oval, the major axis of the ellipse being in the line of the chambers, and the grate is in this case made with bricks and not with iron bars, which is the usual practice; these kilns are generally made to hold about 30 tons of cement, and are said to clear themselves well (that is to say, the clinker does not hang to the lining and tear it down when it falls), and to give satisfaction; but I have no personal experience of their working. Running kilns are such as are constantly kept burning, what is drawn from the eye being replaced by an equal amount of dried slurry and coke introduced at the top; they are built without domes, and the draught in them is consequently not so good as where domes are used, and the clinker is liable to be lightly burnt. They are, however, useful for making up small deficiencies in the day's quantity; they cannot be used as chamber kilns. Hoffman or gas kilns, where there are many charges, one of which beats the next and so on, have been tried in this country, but I believe without success, though they are said to give satisfaction in Germany. The clinker produced by them here is of inferior quality and irregularly burnt.

The clinker when burnt should be of a greenish black color; there will always be a certain proportion in every kiln which is pink or yellow, and therefore underburnt; this should be loaded into the next kiln and burnt again. If there is much dust, the clinker is overclayed and the resulting cement will be weak; underburnt clinker slakes and heats when wet, but this is not the case with well-burnt clinker.

When the clinker is drawn, it is wheeled on to a weighing machine and weighed, and is then thrown into one of Blake's or some similar stone crusher and reduced to about 2-inch cubes. I believe that it would be advantageous to break the clinker much smaller than is generally done, if any machine could be found to do this satisfactorily and at a moderate cost; but so far as I know, no such machine exists, though I hope shortly to hear of one which will do this work. After being broken in the crusher, the clinker is carried by an elevator to the hopper of the mill stones. Formerly these elevators were made with link chains and cast iron buckets with steel lips, but both buckets and chains wore badly on account of the dust, and now India-rubber belting is used with light wrought iron buckets running at a speed of about 90 feet a minute.

The stones used for grinding the cement are French burr stones, and are generally 4 feet 6 inches in diameter, and are driven at a speed of from 120 to 130 revolutions per minute. The quantity of cement turned out by a newly-dressed pair of stones should be from 15 to 17 tons in ten hours.

Fine grinding being the order of the day, it is much to be desired that some substitute for the French burr stones should be found for regrinding the portion of the cement which will not pass through the sieve; but though rollers running at different speeds, steel or chilled cast iron in place of the stones, and cast iron balls rotating freely at a high speed in a mortar have been tried, none have as yet been able to compete with the ordinary mill stones. Some manufacturers sieve the contents and return the coarser particles which will not pass through the sieve to the mill stones by an elevator and endless band or some such arrangement, while others trust to their miller to grind the cement within certain limits.

After the cement is ground it is passed into the store by means of barrows, endless bands, or archimedean screws, and it remains there until it is wanted, when it is filled into sacks or casks, according as it is required for home or foreign consumption, and it is then ready for transit.

On paper, the process of manufacturing cement seems wonderfully easy and simple; but this appearance is illusory, and no one who has not had experience in the manufacture of Portland cement can know the constant watching necessary and the anxiety and trouble which it entails. The materials are accurately weighed, the weighing machine itself, and the weight of the barrows are tested almost daily; surely then the result should be equally accurate.

An analysis of several samples of chalk and clay will show that the materials themselves vary largely in their composition, and that at different times they contain very different amounts of water, and it will be easily understood that the weighing of the raw materials does little more than certify that a certain amount of chalk and clay have gone into the washmill; and in order to make good cement it is necessary, not only to watch the quality of the chalk and clay most carefully and to alter their proportions as circumstances require, but also to take several samples of the contents of the washmill during each day, mix them together, and from this mixture take a sample at random, dry it, and test it for carbonate of lime, so that the average amount of carbonate of lime contained in each day's washing for each washmill may be known on the following day. This test is by no means a certain one, nor does it insure good cement; but it is a guide by which to work, and if the temperature of the atmosphere is taken into consideration, and the burning of the clinker is carefully carried out, it is a considerable help toward the manufacture of good cement.

After the cement is ground, a sample from each day's grinding, taken by throwing a handful from the spout of the mill stones into a box, say every quarter of an hour, is collected, and from this sample three or more small pats, about 3 inches square by one-quarter of an inch thick, are mixed with water and laid on pieces of glass or slate, and so soon as they are set, say in one hour's time, they are immersed in water and remain there three days. They are examined daily, and if they show signs of cracking this is an indication that the cement is overlimed, and the washing must be altered accordingly. These pats also show the strength and tenacity of the cement approximately by the manner in which they come off the slates or glass. If it is good, strong cement, it will leave the plate with great difficulty; if it is weak or overlimed, it will leave the plate easily, and will in the latter case very probably free itself.

After each day's grinding a sample of the cement in the store, from that grinding, is measured in a bushel measure and weighed to test the burning. The usual requirement is that the cement shall weigh 112 lb. per striked bushel. This test is in some ways rather illusory, as the more finely ground cement will weigh less per bushel than that which is coarsely ground, and it is therefore necessary to burn harder to obtain the same result, if the cement is to be finely ground, than is requisite when fine grinding is not required. When the cement has been stored some time and has cooled, it will have expanded to the extent of about 5 per cent., therefore the cement which weighed 112 lb. per striked bushel when it was ground will eventually weigh only 106·4 lb. a bushel, and to obtain cement which will pass the 112 lb. test, it is necessary that it should weigh, when ground, at least 118 lb. per striked bushel. The manner of filling the bushel measure also considerably affects the result, and as there is no standard angle of inclination for delivery, nor height from which the cement should fall, the results obtained by different manufacturers are not the same; and besides all this, the test is illusory, because the weight may be produced by a large amount of lime, by hard burning, or by both combined.

All cement used in this country is tested for tensile strength before it leaves the works, sample briquettes being made from each day's grinding and also from each shipment, collected as above described, either by handfuls from the spouts, or by small quantities from each sack. It has been until lately the practice to give the briquettes a sectional area of 1½ by 1½ inches, equal to 2¼ inches, but they are very generally made nowadays with 1 inch section. The form of the briquettes considerably influences the results obtained, and the manipulation of them further affects the tests; indeed, there are many men who are never able to obtain satisfactory results, and two individuals using the same cement, the same moulds, and the same testing machine will differ by 100 lb. per inch of section in the tensile strain of the sample they manipulate. A fixed quantity of water should be used for each gauging, and there should be just sufficient to work the quantity of cement to be mixed into a fat paste, which is then placed in the mould and allowed to set.

It is the practice to shake the moulds, which are laid on pieces of slate or glass in order to get rid of air bubbles; but there is little doubt that this also affects the result, as the particles of cement not having the same specific gravity throughout, the coarser and heavier portions fall toward the bottom of the mould, the tensile strength will not be the same throughout the section, there will be a tendency toward fracture, commencing on one side before the other, and the result will be below the average strength of the cement. On the other hand, if the air bubbles are not removed, there will be a loss of section equal to their collective area, and the result obtained will also be below the strength of the cement. It is my own practice to work the cement to some extent in the moulds and to shake them a little.

A series of diagrams were exhibited, showing the different forms of moulds which have been in common use, and their respective values. In No. 1 the square corners cause the briquettes to break at these points, and the least irregularity in setting produces cross and transverse strains, the length of the bearing being too great. No. 3 has the same fault to a smaller extent; and there is no doubt that No. 4 is superior to any of the others, as the results obtained from it show; but the corners of the ends might be rounded off with advantage, so as to make them clear the moulds better. No doubt the most perfect form would be the last in circular section throughout; but there would be difficulty in filling the moulds for such a section. They would have to be filled from the ends, and it would not be easy to get rid of air bubbles.

When the briquettes are set sufficiently to enable them to be removed from the moulds, they are placed in water and remain there for six days, when they are broken in a testing machine, and the resulting strains are recorded in a book kept for the purpose, and in which also the tests for carbonate of lime and the days on which each kiln is loaded and drawn are also entered, so that the test for carbonate of lime, for the slurry with which any kiln is loaded, may be known, and also the tensile strength of the cement produced from that kiln. This is the practice I follow myself, and though I am bound to confess that it cannot be carried out thoroughly, on account of the quantity of clinker which must sometimes be put in the clinker store, and which cannot be referred to any particular kiln, yet, as in the case of the test for carbonate of lime, and the weighing of the chalk and clay, it is a guide.

There are many machines in general use for testing briquettes, those best known being De Michele's, Adie's, and Michaelis'. I use De Michele's machine; it is simple, strong, and steady, and there is every reason why the results obtained should be accurate, it being impossible to strain the briquettes before the testing commences; and this is not the case with Adie's machine, as the briquettes have to be screwed up against the lever, and if this be done carelessly, the briquette may be damaged before the weight is applied. In Michaelis' machine the load is applied very steadily and gradually, and this is done by filling a vessel with water; but the double system of levers tends to inaccuracy.

In Germany there is a standard specification for cement. The test for grinding is that there shall not be a residue of more than 20 per cent. after the cement has been passed through a sieve having 76·2 meshes per lineal inch. For the tensile test the cement is mixed with three times its weight of standard sand, and is tested after twenty-eight days, when it must bear 142 lb. per square inch of section. There are considerable objections to this specification. It is impossible to produce a standard sand which shall be always the same, and any variation will affect the testing of the cement. No doubt 28-day tests are of great value, and it would be a good thing if they could be obtained without inconvenience; but such tests cannot be made by the manufacturer at his works; if they were necessary, a full month's stock would always have to be kept on hand, besides accumulation, and the storage room required would be enormous and most expensive. In this country, unfortunately, there is no standard specification, and each engineer specifies in accordance with his own ideas, and the result is, that the manufacturer may have several conflicting specifications to meet at the same time; and not only this, but specifications are often conflicting in themselves. The specification of Mr. Bernays, engineer to the Chatham Extension Works, is as follows: The cement must be of uniform good quality, finely ground, and weighing not less than 112 lb. to the imperial (striked) bushel. All cement that does not bear, without breaking, a weight of 650 lb. upon the test blocks of 1½ in. by 1½ in. sect. will be rejected. The specification of Mr. Grant, engineer to the Metropolitan Board of Works, is put in the shortest form. The cement shall be ground so fine that the residue on a sieve of 5,806 meshes to the square inch shall not be more than 10 per cent. by weight. The cement is to be gauged with three times its weight of dry sand, which has passed through a sieve of 400 and been retained on one of 900 meshes per square inch. All cement that, when neat, sets in less than two hours must bear without breaking a weight of 142 lb. per square inch, and if it take from two to five hours to set when gauged neat, it shall bear a weight of 170 lb. per square inch 28 days after gauging. As written, there is no means of comparison between the specifications, as the tests in one case are made at 7 days and in the other at 28 days, and in the first case neat cement is used, and in the second a mixture of sand and cement; but reduced to equal terms the requirements would be somewhat as follows: Grinding—Mr. Bernays requires a maximum residue of 20 per cent. after passing through a sieve of 2,500 meshes per square inch. Mr. Grant requires that the residue, after passing through a sieve of 5,806 meshes to the square inch, shall not be more than 10 per cent. Tensile test—Mr. Bernays requires that the briquettes shall not break at 7 days with a weight of 288 per lb. per square inch, and Mr. Grant rejects any cement which breaks with a weight of 400 lb. per square inch.

One engineer will specify that the cement is to weigh 109 lb. per striked bushel, another requires that it shall weigh 116 lb. and at the same time be quick-setting and have a tensile strength at 3 days of 150 lb., at 7 days of 400 lb., and at 28 days of 500 lb. per square inch. This is contradictory: cement which weighs 116 lb. per striked bushel must be heavily burnt, and heavily burnt cement, as a rule, means that it is slow-setting, and slow-setting cement will not give a tensile strength of 150 lb. per square inch at 3 days unless it is very highly limed, and in this case, though it may give the required strength of 400 lb. per square inch at 7 days, it is not likely to have a strength of 500 lb. per square inch at 28 days.

The question of fine-grinding is a much vexed one, and the tendency is for engineers to specify that cement shall be ground more finely than was formerly required. It is certain that the cement which will not pass through the meshes of a sieve with 50 wires per lineal inch has little or no cementitious value by itself; but I do not think that it is at all proved that it has no value when mixed with finer-ground particles. On the other hand, the coarser particles of cement are generally those which are best burnt, and would, therefore, if reground, make the best cement, and the very fine particles are, as a rule, weak in cohesion. It seems that finely-sifted cement has less strength than that which is unsifted, when gauged neat, but that the reverse is the case when a mixture of three parts of sand with one of cement is used. Such a mixture, however, is not one which is much employed in practice, and the question arises, Is 40 per cent. additional strength, which Mr. Grant claims for cement ground to the German specification, or somewhat finer, maintained in ordinary concrete as generally used? If it is, then by all means let us have finely-ground cement; but let its use be universal, not occasional. In fact, let there be a specification drawn up which shall meet the views both of engineers and manufacturers, and let it be used for all cement. This question of fine-grinding must be reduced, like a great many other things, to the standard of money. Is it cheaper, with the same efficiency, to use the cement of ordinary quality at the market price, or to pay a higher price for very finely-ground cement? In cases where the carriage is not heavy, and supposing the loss in the coarser cement to be due to the percentage of coarse particles, and that these have no cementitious value, when mixed with the finer cement, which, however, is, I think, not yet proved, then the balance is slightly in favor of the ordinary cement of commerce. But supposing Mr. Grant's estimate of the value of finely-ground cement is correct for concrete, which I also do not think is proved, and when the carriage is heavy, finely-ground cement will be cheaper, at a considerably advanced price, than that which is more coarsely ground. My own feeling is that cement might be much more finely ground than it is at present at slight cost; but when such fine grinding as that specified by Mr. Grant is required, special machinery becomes necessary, and the cement must be handled twice, and the cost of manufacture is greatly

increased. Notwithstanding the arguments of Mr. Grant and others, and the practice in Germany, I do not think that the case, except where carriage is a heavy item, for or against fine-grinding is proved. And there is also another point to be considered: In cases, as at the Chatham Extension Works, where the concrete is made in the proportion of twelve to one, would there be sufficient of the finely-ground cement, when used in the proportion of 30 to 1, which would be the mixture required to give the same strength, if the finely-ground cement has 40 per cent. more value than that which is coarsely ground, to fill up the interstices? If there is not, then the whole argument in favor of finely-ground cement, when used for concrete of this quality—and a very large quantity of cement is used in this way—falls to the ground.

All cement should be kept at least a fortnight before it is used, and during this time it should be spread out on a dry floor to a depth of not more than three feet, and as much less as possible, and turned over at least twice, so that it may be thoroughly cooled, and any free lime which may be present may be slaked. The desire evinced by many engineers for high tensile tests involves the danger of the presence of free lime, and where this exists, the ultimate disintegration of the work constructed with it is more than probable; for a high tensile strength at 7 days, which often means the presence of an excess of lime, does not by any means guarantee that the strength at 28 days will be, as Mr. Faija says it should be, 25 per cent. higher than it was at 7 days—rather the reverse. A sample of cement which broke at 7 days, after gauging, at 300 lb., will often, after the lapse of a year, have a strength of 700 lb. per square inch, while the sample which broke at 450 lb. at 7 days will, at the end of the year, give no higher test, and at the end of three years will probably have begun to disintegrate. Cement made with a large proportion of lime, and lightly burnt is, most dangerous. Heavily burnt cement is hard to grind, it is generally slow setting, and it gives a low tensile strength at short periods, and gradually increases in strength for an indefinite time.

I submit the following specification for your consideration. It will not meet all requirements—no standard specification will do that; but if some standard specification could be agreed on, it would be a benefit alike to engineers and manufacturers. You may imagine how it must hamper the latter to have to meet the requirements of half a dozen entirely different and conflicting specifications at the same time, each necessitating a different mixture of chalk and clay, a different rate of burning, and a different fineness in grinding:

"The weight per bushel, after cooling, to be not less than 112 lb., and not more than 118 lb. per striked bushel, the measure being 6 inches deep, the angle of inclination 45 per cent., and the length of the board 2 feet, and the fall from board to top of measure 6 inches, the cement being fed from a flat plane at the level of the top of the board, into the board.

"The tensile strength of the test briquettes, 7 days after gauging, and 6 days after immersion in water, to be not less than 335 lb., and at 14 days not less than 385 lb. per square inch. All the briquettes to be of the form shown at No. 4, and one standard machine to be used for testing. The cement to be ground to such a fineness that, on sifting through a sieve having 50 meshes per lineal inch, the residue shall not be more than 10 per cent."

The following is an analysis of finished cement taken from Mr. H. Reid's work on the subject:

Silica	22·74
Alumina	7·74
Oxide of iron	3·70
Lime	56·68
Magnesium	0·57
Alkalies	0·63
Sulphate of lime	1·66
Carbonic acid	3.50
Undissolved residue	0·53
Water	1·90

Portland cement is much more easily made in winter than in summer. In hot weather the cement made in exactly the same proportions, and burnt to just the same extent as at other times, will set so rapidly that it can scarcely be handled, and it is also very apt to crack. This arises presumably from the difficulty in getting rid of the mechanical heat in the cement. It is perfectly true that the manufacture and use of cement has made rapid strides of late years, but there is more yet to be done both in the direction of improvement, in regularity, and in reduction in prime cost. Cement manufacturers are generally troubled with bad water and this is a fruitful cause of expense; fuel is a large item, and this might I think be reduced; labor, again, is a heavy charge, and in many cases machinery would do the work better and more cheaply, as for instance in distributing the cement and shipping it; and last, but not least, means should be found for more efficiently crushing the clinker before it goes to the millstones, and for grinding it after it has got there. All these things are matters of detail, only to be arrived at tentatively, and after careful observation.

The uses to which Portland cement may be put are various; but it is most extensively employed in the manufacture of concretes, and in this form it serves for the construction of dock-walls, retaining walls, foundations, piers and jetties, sea walls, bridges, floors of bridges and of houses, sewers, sewer pipes, flags, tiles, baths, bricks, mantelpieces, mouldings, and ornamental work generally. The Chatham Extension Works are built almost entirely of concrete in the proportion of twelve of the aggregate to one of cement, mixed and laid *in situ* with a facing of concrete made in the proportion of six to one. The Albert Dock is made almost entirely of concrete laid *in situ*. Dover and the Tyne Piers and others are made with blocks of concrete. The roadways of a large proportion of our streets are laid on a foundation of concrete; many of our sewers are made entirely of concrete; and sewer pipes, which are far stronger and more watertight than those constructed of stoneware or fireclay, are made of the same material, which is also used where fireproof floors are wanted.

Foundations are almost invariably made of concrete, which adapts itself to inequalities of surface. Concrete bricks, made of breeze and cement, in the proportion of six of the former to one of the latter, and pressed in an hydraulic press, can be made in the morning and built into the work in the evening, and this at about the same price as stock-bricks, and they can be turned out in almost any weather. Houses may be built of concrete laid *in situ*, and they have the advantage of being almost entirely vermin-proof; but they have also the disadvantage that they are very hard to pull to pieces and alter. Concrete may be made into slabs and polished, or it may be used for ornamental mouldings and cast like metal or clay, and it is exceedingly well adapted for such work, for it takes a very sharp impression, as may be seen by any one who looks at the face of a concrete retaining wall, where the grain of the timber used in building will be found exactly reproduced in the cement. Any desired color may easily be given to the concrete through the medium of the aggregate. Concrete is particularly well adapted for engine and machine foundations. The engine or machine may be blocked up to its proper position and the concrete cast under it until every cranny is filled, and the bolts are set perfectly solid in the mass. Concrete slabs are used for paving footways, and offer a much more even and enduring surface than York flags—that is, if they are properly made, and this process holds good for all concrete work: it must be properly made. Care must be taken that the cement is of good quality and not liable to blow; that is to say, that it is does not contain free lime, that it is properly slaked, and that it is not used in the manufacture of concrete after it has once set, unless it is reburnt and reground. Failures in concrete walls are common, not because the concrete is faulty, though it will not adapt itself to circumstances as a brick wall will, and any settlement will cause cracking, and then cracks cannot be easily mended; but because sufficient care is not taken to make the foundations secure, and the wall is carried up to its full height in short lengths; whereas the building should be constructed to as great a length as possible at once, but only to a height of 1 foot 6 inches or 2 feet; and when the next layer of concrete is laid, the surface of the last layer should be cleaned and damped, and if it has been standing for a long time, it should be dusted with neat cement. Concrete should be made as required: if it is allowed to set before being put into the work, it is useless, and setting begins very early; some light burnt cements, when gauged neat, will begin to set within 40 seconds of the time when the water is added, and all cements set quicker in hot weather than when it is cold. The more the cement is agitated the longer time will it be before it sets, and concrete takes longer to set than neat cement; otherwise it would be almost impossible to handle it.

Portland cement is largely used for stucco, and it often fails and flakes off. This again is caused either by the cement not having been sufficiently cooled by natural heat, or by the surface of the wall not having been properly damped, causing the previous bricks or stone to absorb the moisture required by the cement. Improper materials are frequently mixed with cement. Where sand and gravel are used, they should be clean and sharp: loam or anything of that nature kills cement.

The proportions to be used in the manufacture of concrete must depend entirely on the work to be done and on the nature of the materials which can be obtained to form an aggregate. We have seen that a proportion of 12 to 1 gives a good result when large masses are used, as in the case of foundations, dock walls, piers, and jetties built *in situ*; but the sand and stone, or whatever the aggregate is formed of, must be sharp and strong. If soft and porous stone and dirty sand be used, a larger proportion of cement will be required. For small work a proportion of 6 to 1 is satisfactory, and this is I believe a strong enough mixture for flags 3 inches thick, if concrete made in the proportion of two parts of well washed granite chippings to one part of cement be used for the face ½ inch thick. No sand should be used in face work, for if it is present, the concrete will wear into holes, as may be seen in many concrete walls. Broken slag makes good concrete, and so does broken brick; but whatever the material used for the aggregate, there must be a sufficient proportion of finer matter, whether this be sand or cement, or cement alone, to fill up all the interstices, and make the whole one mass.

The quantity of water to be used in mixing must vary with the materials employed; for instance, broken brick will require more water than granite, and in frosty weather as little water should be used as is possible. As concrete sets more rapidly at a high than at low temperature, and it will not set safely in frosty weather, it is desirable in the construction of slabs, moulding, and ornamental work generally, that the temperature during the time of setting should be high, and as even as possible. To meet this end, Mr. Faija has invented and patented a process, by means of which slabs or blocks can be moulded one day and turned out the next, without resorting to hydraulic pressure, thus doing away with the necessity for a large number of moulds, and reducing the cost of manufacture; and as I have said before, cement is eminently adapted for the manufacture of mouldings, which may be made comparatively light, and at the same time very strong.

The cost of manufacturing concrete varies very largely in different localities, and depends on the distance the cement has to be carried, and on the price of a suitable aggregate at the spot where it is used; but under ordinary circumstances it is much cheaper than brick or stone work of equal strength so far as the actual material is concerned; but it cannot be used in the same manner, but must be made into bricks, or blocks, or cast into a wooden or metal framework of the form of the building or block to be made, and the cost of such framework must be added to the price of the material and labor. In the case of a dock or other large work of that description, the cost of the framing will scarcely affect the price of the concrete, but when a single house has to be built, special frames must be made, and they will form a large item in the total cost. When, however, the same frames can be used for many buildings, this expense will be greatly reduced. For a single house it is more than questionable whether stone or brick would not be cheaper than concrete, as either is certainly handier to work with. Mr. Bernays puts down the price of concrete made in the proportion of 12 to 1 at 7s. 2d. per cubic yard; of 9 to 1 at 8s. 2¼d.; of 6 to 1 at 10s. 3d. per cubic yard—to which must be added from 4d. to 6d. per yard for framing. I believe that pressed concrete bricks may be made cheaply, and they would be easy to build with, and as serviceable, and that they can be made with sharp square edges and faced as required, and at a reasonable price. Altogether, the field for the use of Portland cement is very large, and will, I believe, be still further extended as greater confidence is placed in the material, which will, in its best form, outlast any stone.

I have no doubt that improvements will be made in the manufacture of Portland cement, beyond those which have already come into effect, and I trust that both engineers and manufacturers will direct their attention to its perfection and to the extension of its uses, and that between them they may arrive at some standard specification which shall be accepted on all hands.

MR. FLINDERS PETRIE is about to publish a work on the measurements of the Great Pyramid, in which he will show that the new measurements are irreconcileable with those on which Prof. Piazzi Smyth has built his hypotheses.

A NEW METHOD OF SOLAR PHOTOGRAPHY.

A DISCOVERY, or invention, of the highest importance, in connection with photographing the sun, was communicated by Dr. Huggins to the Royal Society at its last meeting, and it bids fair to forward the progress of research into questions of solar physics in a manner and to an extent that previously had scarcely been hoped for. Our readers are aware of the great interest that has attached to total eclipses on account of certain phenomena being visible which at no other time had been observed; and, though the progress of science had enabled methods to be devised which permitted some of the phenomena once seen and noted to be observed and photographed in ordinary daylight, a certain class of them had, up to the time of Dr. Huggins' communication, been beyond the power of observation.

The phenomena we speak of are those long streamers, flames and beams which, forming a visible crown of glory round the sun during an eclipse, have received the appropriate designation of the "corona." The other phenomena accompanying an eclipse, but which need not here be noted, have been seen without the intervention of the moon through the medium of the spectroscope; but, as the corona gives, in the main, a continuous spectra such help would be useless.

The corona consists of a number of remarkable radial filaments, beams, and sheets of pearly white shooting out, sometimes to several degrees, beyond the sun's border, and for a long time they have formed a puzzle to all astronomers. Though the spectrum they give has bright lines, it is, in the main, continuous. The beams, and rifts between them, though sometimes evanescent in character, usually last for hours, perhaps for days and weeks, and, when seen from far distant parts of the earth's surface, possess the same appearance.

They are invisible during ordinary daylight by reason of the extent to which the atmosphere of the earth is illuminated, the effect being that of a bright fog or haze, which hides these less luminous appendages of the sun, just as a slight fog upon the earth would hide the light of a taper at a few yards, though it fail to obscure a brilliant gas-burner. This atmospheric illumination or glare is the result of the atmospheric particles scattering the sun's light, which are thus taken into the eye at the same time as the coronal light, and are powerful enough to hide it. For many years Dr. Huggins has been trying to eliminate this atmospheric effect in one direction without success, owing to many causes which need not be here enumerated; but it lately occurred to him that the very causes of this want of success for the end he was seeking would in the case of the corona be of actual service.

The corona abounds with those rays which have most effect upon the photographic plate—the rays about G and H—while the atmosphere contains an even admixture of all sorts. Dr. Huggins tried the qualities of various glass to find one that only allowed these G and H rays to pass through, and by this means lessened the disturbing effect of the atmospheric glare by robbing it of most of its light while allowing the chief constituents of the coronal light to pass through unweakened, and so able to overpower the residual atmospheric rays of the same kind. So far so good: but for eye observation these particular rays are the weakest, and as it was desired to obtain a knowledge of faint and shadowy variations that exist upon the coronal forms—which variations were, further, of a transient nature—Dr. Huggins came to the conclusion that eye observations would not answer his purpose. Photography, however, taking the greatest cognizance of these very rays, offered the necessary aid; and thus by placing colored glass at some point between the sensitive plate and the sun, the atmospheric rays were expected to be insufficient to prevent a photograph of the corona to be secured.

Before detailing the effects obtained it will be well to describe the actual means employed. Not being sure of the degree of correction for chromatic aberration in a photographic lens he first employed, Dr. Huggins made use of a reflecting telescope without eyepiece, there being, as our readers are aware, no chromatic dispersion when using a mirror in place of a lens. A camera was put at the side of the telescope, and the rays reflected by a plane mirror into the camera, where they were focused upon the ground glass. The colored glass was placed immediately in front of the ground glass, or the sensitive plate when *in situ*. The glass chosen was pot-metal violet of a particular shade, selected, ground, and polished, several pieces being used together and temporarily cemented by castor oil to avoid reflections from their surfaces. The sensitive plates were gelatine, and were backed by a solution of asphalt in benzole. The front of the telescope was provided with an adjustable shutter; not fitted directly upon the telescope, but connected with it by a piece of black velvet—a wise precaution to prevent vibration.

Dr. Huggins stats that in his later experiments he used a solution of permanganate of potash held in a vessel with true, carefully-polished sides. This, he states, "may be considered as restricting the light to the desired range of wave length, since light transmitted in the less refrangible part of the spectrum does not affect the photographic plates." Though he does not speak of any special plate, we can scarcely infer that he is unacquainted with the fact that ordinary gelatine plates have a range of sensibility for rays well into the red direction. The exposures given were varied in length—some so short that the sun's proper light was photographed and others so much longer that the sun's image was reversed, and the reversal extended to the lower part of the corona.

It is singular, in experiments of such moment, that, to prevent any possible halation, the precaution was not adopted of obscuring by some means the actual image of the sun itself, though such a method is alluded to in the latter part of the paper, as being probably an advantageous one. It states that the climate of our country is very unpropitious, there being few days of sufficient atmospheric clearness to allow those photographs to be taken; still, though the experiments were only begun in May, twenty successful photographs were secured.

With regard to the results obtained, the statements in the paper are very guarded. Dr. Huggins says that in all the twenty photographs the coronal form appears to be present. This appearance does not consist simply of increased photographic action immediately about the sun, but of distinct coronal forms and rays, admitting in the best plates of measurement and drawing from them. This agreement in plates taken on different days "makes it evident we have not to do with any instrumental effect." Professor Stokes writes: "The appearance is certainly very coronal-like and I am disposed to think it probable that it is really due to the corona;" and Captain Abney says: "I think that evidence by means of photography of the existence of a corona at all is as clearly shown in the one case (the eclipse photographs of May last) as in the other."—(*Dr. Huggins' New Photographs.*)

We have thus placed in brief before our readers an account of this most interesting and cleverly-devised plan. It is evident that similar photographs with studio appliances on a suitable day can be secured, but, whatever optical method be adopted, astronomers, we may be sure, will look forward to a continuance of the study of the phenomena of the corona with eager interest.—*Br. Jour. of Photo.*

HOW TO REMOVE BICHROMATE STAINS FROM THE HANDS.

THE action of chromic acid on albuminous and gelatinous substances has it inconveniences. Workers with solutions of bichromate of potash find that the skin of their hands, after immersion in the solution for a moderate time, followed by drying and some exposure to light, has received the familiar reddish-brown stain, which is not thoroughly removed by soaping. With care, no doubt, these stains may be kept within moderate bounds; but those who have continually to employ bichromate solutions cannot always be so circumspect as they desire.

We would recommend those who get stained fingers, and may wish to join the social circle without such an *affiche* of their occupation, to pour a little solution of sulphurous acid on to their hands. On rubbing the fingers they will find the stains rapidly bleach. Subsequent washing with rain or distilled water would be preferable; but ordinary water could hardly make a preceptible difference.

Solution of sulphurous acid is purchasable at a low price, and could, for this purpose, be made at a cheaper rate than usually quoted; but as the photographer has always a solution of hyposulphite at hand, he need not even go to the expense of doing this. If he will only take a warm, strong solution of hyposulphite, and add thereto a small quantity of ordinary sulphuric acid, the same bleaching action as with sulphurous acid will take place.

Now that bichromate solution is so much used in the photographic operations connected with photo-etching and photo-lithography, to say nothing of carbon printing, the removal of stains has become a matter of some importance, and the means we recommend is not only one of the simplest and most efficient that can be named, but perfectly free from any injurious influence.—*Photo. News.*

ACETATE OF SODA AND ITS LATEST USES.

A NEW interest now attaches to this substance, purity being matter of no consequence. We have on a previous occasion referred to the use of acetate of soda for the foot-warmers of railway carriages, and the substance possesses such exceptional properties that it may become of great service to photographers for imparting heat to drying-boxes, heating small rooms, and, indeed, for a variety of purposes where a portable heating apparatus without fire on a small scale is needed.

The employment of hot-water bottles for such purposes is well known, and from the great capacity of water for heat—which is greater than that of any other liquid—a considerable amount of heat can be stored up in a small space. The objection to the use of water, however, is the quickness with which (unless protected by a good non-conductor) it parts with its heat, a large bottleful becoming cool in a very short time. With acetate of soda, however, in place of water, a given bulk, after having been heated to fusion, will give off more heat and remain at a high temperature for a far greater time than water; so that a drying cupboard with a gentle draught through it, supplied with an acetate warmer over night, would, when inspected in the morning, still show plenty of heat after the lapse of twelve hours—a property of a most useful character where gas is unavailable and continuous attention cannot be given.

Some incredulity may be felt at this account of the property of the salt; but it should be borne in mind that at the moment when bodies in a state of fusion or solution become solid a very large amount of heat is given off. A very familiar instance of this is seen in the behavior of hypo. A few crystals placed in a small flask and gently heated will soon fuse, and if the flask be left still quite cold its contents will remain perfectly fluid. Let, however, one small crystal of hypo. be dropped in, and the whole will become solid in a second or two, and so much heat will be disengaged that the cold flask will become so hot that the hand can only just bear it. The heat that had been absorbed and rendered latent so long as a state of fluidity was maintained became unnecessary when the solid form was assumed, and so was set free, as it were.

It will be obvious from this that the heat is not produced from nothing, as before the acetate or any substance can be utilized to give heat it must in the first instance be imparted to it. The acetate requires a great quantity of heat—not necessarily a high temperature—to liquefy it, and, in consequence, can give off a great quantity when it has been liquefied.

M. Ancelin—the inventor of the system of using this salt for the purpose—has been making a series of experiments which may be briefly epitomized for our purpose: Filling a railway "foot warmer" of about two gallons' capacity with hot water, and another with acetate, and rendering it liquid by heat, he compared the action of the two. In about four and a half hours the former, starting at a temperture of about 180° Fahr., became reduced to 104°—a temperature below which it would be useless for the purpose. The cooling, too, though quick, was at an even rate.

When acetate of soda was used (the same-sized pan, it must be observed, held four or five times the weight of acetate as it did of water) a lower initial temperature was given, and up to a certain point—about 120° Fahr.—the fall in temperature coincided with that of water. At that point, however, instead of, as in the case of water, continuing to fall in temperature at the same rate the cooling was very gradual—only about one degree per hour. The point at which this sudden decrease in rate of cooling took place corresponds with that at which crystallization begins; but, instead of the heat of solidification being disengaged at once, as in the experiment with hypo. we described, the crystallization is gradual, and the disengagement of the heat also gradual.

It will thus be seen that acetate of soda promises to be a still more useful servant to the photographer than ever, and we feel quite assured that in the direction we have described it may perform many most useful functions.—*Br. Jour. of Photo.*

IT has been found that sunlight has a considerable action upon glass. Colorless glass, for example, has become yellow, and light yellow, green and blue have turned to the darker or mellow shades of those colors, while coffee-colored glass has been known to change to rose and amber in five years.

ON THE LIQUEFACTION OF OXYGEN AND NITROGEN, AND THE SOLIDIFICATION OF SULPHIDE OF CARBON AND ALCOHOL.*

By S. WROBLEWSKI and K. OLSZEWSKI.

THE following dispatch was addressed in the first place by M. Wroblewski to M. Debray on April 9:

"Oxygen liquefied; completely liquid; colorless, like carbonic acid. You will receive a note in a few days."

The note M. Debray has since received, and it reads as follows:

"The beautiful investigations of MM. Cailletet and Raoul Pictet on the liquefaction of gases permitted the hope that some day chemists would be able to observe oxggen reduced to the liquid state in glass tubes, as is done at present in the case of carbonic acid; the condition being solely to obtain a sufficiently low temperature. M. Cailletet, in a note published a year ago,† recommended liquefied ethylene as a means for obtaining very intense cold. This liquid *under the pressure of one atmosphere*, boils at —105° C. if a sulphide of carbon thermometer is employed to measure the temperature. Having compressed oxygen in a capillary tube and cooled in this liquid to —105° C., M. Cailletet observed, at the moment the pressure was released, 'a tumultuous ebullition, persisting for an appreciable time and resembling the projection of a liquid in the cooled part of the tube. This ebullition forms at a certain distance from the bottom of the tube. I have not been able to recognize,' adds M. Cailletet, 'if this liquid pre-exists, or if it is formed on releasing the pressure, for I have not yet been able to see the plane of separation between the gas and the liquid.'

"Profiting by a new apparatus constructed by one of us (Wroblewski), which allows the placing of relatively large quantities of gas under pressures of some hundred atmospheres, we proposed to ourselves to study the temperature of gases during the detent. These experiments have soon led us to the discovery of a temperature at which sulphide of carbon and alcohol freeze, and at which oxygen liquefies completely with great facility. This temperature is obtained by allowing ethylene to boil in a vacuum. The temperature depending on the degree of the vacuum obtained, the minimum we have been able to obtain till now is —136° C. We have determined this temperature, like all the others, with a hydrogen thermometer.

"The critical temperature of oxygen is lower than that at which ethylene boils under atmospheric pressure. This latter is not —105° C., as has been admitted till the present time, but it lies between —102° and —103° C., as we have found with our thermometers.

"From a series of experiments which we have made on April 9, we give the following numbers as an example:

Temperature.	Pressure in Atmospheres under which Oxygen commenced to liquefy.
131·6	26·5
133·4	24·8
135 8	22·5

"In publishing these numbers we reserve for our next note the communication of definite values.

"Liquid oxygen is colorless and transparent, like carbonic acid. It is very mobile, and forms a sharp meniscus.

"As to sulphide of carbon, it freezes at about —116° C., and melts at about —110° C.

"Alcohol becomes viscous, like oil, about —129° C., solidifying about —130·5° C., forming a white body."‡

On April 10, another dispatch was sent by M. Wroblewski:

"Nitrogen cooled, liquefied by detent; meniscus visible, liquid colorless."—*Chem. News.*

MEASUREMENTS OF THE WAVE LENGTHS OF RAYS OF HIGH REFRANGIBILITY IN THE SPECTRA OF ELEMENTARY SUBSTANCES.‖

By W. N. HARTLEY, F.R.S.E., etc., Professor of Chemistry, Royal College of Science, Dublin, and W. E. ADENEY, F.C.S., Associate of the Royal College of Science.

THE authors describe a method of taking photographs of diffraction spectra produced by a small Rutherfurd speculum ruled with 17,460 lines to the inch. The lines in the spectra were accurately measured by the aid of a microscope magnifying 25 diameters, and a dividing engine.

The length of the spectra which were taken on three different plates was 14 to 15 inches, and the measurements were accurate to the $\frac{1}{5000}$ of an inch. From these measurements the wave-lengths of the lines were calculated. The spectra include lines with wave-lengths 4,674 and 2,024. They were produced by electric sparks condensed by a pane of glass coated with tin-foil.

Of the electrodes used, *one always* consisted of cadmium, the other of the metal or the solution of the metal, or other elementary substance, the wave-lengths of the lines of which were to be determined; thus all the spectra were referable to the cadmium lines. Great accuracy is attainable by this method, and lines which have appeared identical or coincident in two different spectra have thus been proved to differ in refrangibility.

All the spectra were compared with spectra obtained with the prism spectroscope described by one of the authors in the *Scientific Proceedings of the Royal Dublin Society*, vol. iii., part iii., April, 1881.

Great care was exercised in taking the photographs, lest any irregularity in the surface of the plates should lead to inaccurate measurements. Gelatin films on specially selected *patent plate* glass were used, and such a precaution is quite necessary. The photographs were not varnished. A certain number of lines measured by previous observers have been compared with the new measurements. Taking the numbers given by Thalen, Lecoq de Boisbaudran, and Cornu for 150 lines in the spectra of magnesium, zinc, cadmium, aluminum, indium, thallium, iron, etc., a close agreement with their measurements affords satisfactory evidence of the accuracy of these determinations. Besides the wave-length, a very careful description of the appearance of each line is given, together with its linear measurement, indicating its position on a series of photographs obtained with the prism spectroscope, which series of photographs is presented with the paper. A distinction is drawn between those lines determined directly with the grating and others too faint to be seen on diffraction photographs, which were measured by the aid of the prism spectroscope and an interpolation curve 9½ meters in length. The total number of lines measured and described is 2,247, namely: Magnesium, 42; zinc, 151; cadmium, 141; aluminum, 30; indium, 104; thallium, 70; copper, 164; silver, 124; mercury, 80; carbon, 20; tin, 129; lead, 86; tellurium, 322; arsenic, 112; antimony, 211; bismuth, 156; air, 215; and iron, 150.

A series of eighteen enlarged photographs, 36 inches in length, are presented with the paper, on which each line has its wave-length written over it.

* *Comptes Rendus*, t. xcvi., p. 1140.

† Ibid., t. xciv., pp. 1294-1296.

‡ These experiments were made in the laboratory of M. Wroblewski, at Cracow.

‖ Abstract of a paper read before the Royal Society, April 19, 1883.

THE MANUFACTURE OF MAGNESIA.

THE manufacture of magnesia for a variety of purposes is beginning to assume proportions abroad that render it a subject of interest. Sorel, as early as 1867, called attention to the fact that pure caustic magnesia, mixed with a solution of chloride of magnesium, becomes a solid mass, which has the hydraulic qualities of cement. He established works in Paris, which still make a very white cement, capable of being colored and used for a variety of purposes. Sorel uses magnesite from the island of Eubœa as a raw material, because it is exceptionally pure and free from quartz. A year later, Caron published experiments proving how refractory magnesia is. He found that magnesite calcined at the highest temperature was not sufficiently plastic alone, and he therefore mixed it with from 5 to 10 per cent. of slightly calcined magnesia, and this mixture is recommended in manufacturing refractory materials from magnesia obtained by any process, because the bricks and crucibles made shrank but little. His results did not attract much attention until the importance of the basic dephosphorizing process was admitted, and then German chemists suggested the final liquors obtained in the manufacture of potash salts at Stassfurt and Leopoldshall as a raw material. The bulk of these liquors was wasted, although they contain from 27 to 30 per cent. of chloride of magnesium. It is estimated that when 70,000 cwt. of carnallite are daily treated, the final liquors hold from 16,000 to 18,000 cwt. of anhydrous chloride of magnesium, from which 5,000 cwt. of magnesia could be manufactured daily.

Herr Ramdohr some time since, at a meeting of the Society of Engineers, described the method of manufacture adopted. The plan of precipitating the magnesia with burnt lime has never been practically adopted, because the magnesia precipitated is very voluminous, and cannot readily be rid of the chloride of calcium adhering to it; nor has the Closson system of substituting dolomite for lime been introduced. The system actually in use by Messrs. Ramdohr, Blumenthal & Co. for about a year, after almost two years of experimental work, is to decompose the chloride of magnesium by heating it. It has been known for a long time that chloride of magnesium is partially decomposed by being subjected to an elevated temperature, magnesia and hydrochloric acid being formed. But from 9 to 10 per cent. of chlorine remain in the solid residue when heating is simply resorted to. By using an oxidizing flame and highly superheated steam, no trouble has been found in obtaining nearly chemically pure magnesia and hydrochloric acid of 21 degrees Baume, and besides gathering the bromine in the solution. The magnesia thus made is fine white powder, which absorbs carbonic acid and moisture from the air if dried at from 180° to 200° Celsius; but it loses this property to a great extent when calcined at a white heat. Magnesia dried at a low temperature is pronounced a superior material for cement, five parts of it being mixed with four parts by weight of a solution of chloride of magnesium of from 25 to 30 Baume. It is stated that this cement will bear a very large admixture of sand—as high as twenty times its weight. Magnesia is now also used as a basic lining. Messrs. Ramdohr, Blumenthal & Co. ship their magnesia to Messrs. Vygen & Co., of Duisburg, who make magnesia bricks which are said to be very hard, sharp, and refractory, and have a density of from 2·9 to 3. No sintering material is necessary for these bricks when burnt at a white heat.

COLORED GREEN COFFEE.

DR. J. NESSLER has examined green coffee of so bright a color that it was supposed to have been colored artificially. In many cases this supposition is not justified by facts.

Six different samples of slightly green coffee and six more of a yellow color were treated in separate portions with distilled water and with well water respectively, and left standing for twenty-four hours. All of the extracts made with distilled water were green. All of the green samples of coffee and two of the yellow ones gave intensely green extracts in well water. All the yellow samples as well as the green ones gave fine green extracts when treated with diluted lime water. It is evident that viridic acid is formed if the water contains lime, while this is not the case when distilled water is used. The supposition that all green coffee is artificially colored may have arisen from the formation of viridic acid. Slightly alkaline liquids like dilute soda, strontia, and baryta, as well as albumen, are colored bright green by pale green coffee beans.—*Chem. Zeitung.*

FERMENTATION OF CELLULOSE.

HOPPE SEYLER has recently proved what Popoff had already stated as probable that cellulose is converted into marsh gas and carbonic acid by ferments in the slime of the sewers.

A small portion of this slime was taken that had been purified by washing, and was of known composition, that is to say, 1st, the total quantity of organic matter was determined; 2d, the quantity of cellulose insoluble in alcohol, ether, dilute hydrochloric acid, and dilute caustic soda lye. This slime was put in a bottle with a weighed quantity of filter-paper, containing a known quantity of cellulose, distilled water added, and the bottle closed. The gases evolved were collected over mercury and amounted to about 20 or 25 c. c. daily, of which rather more than 50 per cent. by volume was carbonic acid gas, about 45 per cent. marsh gas, and a few per cent. hydrogen. The experiment lasted 13 months, and the weight of the carbon given off in these two gases was more than twice as great as the weight of all the organic matter in the slime itself. Hence the greater part of the carbonic acid and marsh gases must have been formed from the filter paper.

Since the yeast for this kind of ferment is found in every slime that contains organic matter, this process of cellulose fermentation must be going on on a large scale everywhere on the earth's surface if the temperature permits of it. Hoppe-Seyler experimented with a temperature of 20° C. (68° Fahr.)—*Chem. Zeitung.*

ON INSENSIBILITY ARISING FROM A DEFICIENCY OF OXYGEN IN THE AIR.*

By WILLIAM WALLACE, Ph.D., F.R.S.E., F.I.C., F.C.S.

THE evil effects of breathing the air of crowded apartments were formerly ascribed to the existence in such air of an abnormal quantity of carbon dioxide, usually called carbonic acid gas, which was stated to be a deadly poison; but the views of chemists and physiologists in regard to this have been much modified of late years, and some authorities have gone so far as to express the opinion that it is not a poison at all, in the ordinary sense of the word. A little consideration will show that the effects resulting from breathing the air of a confined and overcrowded apartment cannot be due exclusively, or even chiefly, to the presence of carbonic acid gas; for that gas, as well as the aqueous vapor of the breath, is formed at the expense of the oxygen of the air, which diminishes in constant ratio to the increase of the products of the combustion of our food. For every per cent. of carbonic acid gas produced, there is a little more than 1 per cent. of oxygen taken up. Allowing, then, that carbonic acid is to some extent detrimental to the system when breathed, the effects to which I have referred are, at least partly, due to the diminished proportion of oxygen; and there is the further complication of an atmosphere saturated with aqueous vapor, and contaminated with the undefined volatile organic emanations from skin and lungs, which give a peculiar and oppressive feeling of "closeness" to the overcrowded and unventilated room. I think, however, that physiologists are now agreed that the lethargy, amounting in extreme cases to coma, produced by breathing such air, results from deficient oxygenation of the blood; and it is a fair inference that the most important factor in the phenomenon is the lessened proportion of oxygen. The normal proportion of that gas is from 20·9 to 21 per cent. of the air when freed from aqueous vapor; and Dr. Angus Smith has shown conclusively that this proportion cannot be altered, even to the extent of ¼ per cent. without producing appreciable effects, while a loss of ½ per cent. gives rise to serious inconvenience, and air containing only 20 per cent. of oxygen may produce grave consequences if breathed for a considerable time. On the other hand, a man can breathe, for a short time, an atmosphere containing only 16 per cent. of oxygen and about 4 per cent. of carbonic acid gas. When the deficiency of oxygen exceeds this to a sensible extent, a candle refuses to burn, and a man exposed to it is speedily overcome and becomes insensible.

In all ordinary instances of this kind there are the complications I have spoken of, and I have thought the Society would be interested in a case which came under my notice about six months since, in which there are no such complications.

In the construction of a railway bridge over the Forth, near Alloa, a number of iron cylinders were sunk in sections or rings of 6 feet diameter and several feet in height, and making up in all, when finished, about 60 feet. I will not go into the mechanical details of the construction of the cylinders, except in so far as to say that the sections were placed one on the top of the other in such a way that a rather wide space was left all round, which had to be filled up from the inside with a rusting composition, well known to engineers, composed of iron turnings mixed with a small quantity of flowers of sulphur, with the addition, in some cases, of a little powdered sal-ammoniac. This mixture, when wet with water, soon oxidizes, and swells up so as to completely fill up the spaces into which it is thrust. At the Alloa bridge a considerable number of the cylinders had been erected, the most of the "rusting" having been done by one man, who mixed up the composition with water in a pail and applied it to the joints without being affected by it to any appreciable extent. On one day, however—I think about the beginning of May—when there was a perfectly still, somewhat hazy atmosphere, and considerable heat without direct sunshine, this man was observed to become overpowered by some mysterious influence, and a companion descended by a windlass on the top to bring him up. He managed to get him propped up in the bucket, in which he was pulled up to the fresh air, when he soon revived, but his deliverer was in turn overpowered, and, falling back into a pool of water at the bottom of the cylinder, was drowned. One of the contractors now descended, taking care to fasten a rope to his body in case he too might be rendered insensible by the noxious gas, which was now supposed to be present at the bottom of the cylinder; and fortunately so, for he speedily succumbed, and was immediately pulled up by the rope.

On being consulted regarding this apparently mysterious occurrence, I at once saw that the theory of an accumulation of carbonic acid or other noxious gas at the bottom of the cylinder was untenable, for the bottom was covered with water, and no gas could have come up from the bed of the river without being seen bubbling through the water. A few experiments with the rusting composition, a quantity of which was supplied to me, clearly showed that it absorbed oxygen from the air with great rapidity, so that in one of my experiments a portion of air was deprived of its oxygen in ten minutes to such an extent that it would no longer support the combustion of a candle, and in two hours 16 per cent. was absorbed. In another case, continued for a longer period, a loss of 20½ per cent. occurred, or nearly the whole of the oxygen. At the same time the mixture became very warm, the temperature in one case rising to 156° F., while the iron oxidized and the mixture acquired a brown color. I had no hesitation, therefore, in ascribing the accident to the absorption of the oxygen of the air in the cylinder by the rusting composition, coupled with the peculiar condition of the atmosphere, which, while it favored chemical action between the oxygen and the iron and sulphur in the mixture, prevented the circulation of the air in the cylinder, which usually took place to a sufficient extent to prevent serious consequences. The deadly gas at the bottom of the cylinder was therefore nothing more nor less than the nitrogen which constitutes four-fifths of the bulk of our atmosphere, but which, deprived of its companion oxygen, is entirely unable to support respiration. We have in this unfortunate occurrence, by which one life was lost and others endangered, a justification of the German name of nitrogen, stickstoff,—which may be freely translated choke-stuff or choke-damp,—a name which in our language is applied exclusively to carbonic acid gas.

* Read before the Philosophical Society of Glasgow.

PROF. COHN, of Breslau, Germany, has observed that children are obliged to hold dark-colored slates much nearer the eyes to read writing thereon than is necessary with white paper, and finds that writing on white paper is as distinct at a distance of twelve inches from the eyes as that on slates at eight inches. It would therefore be well to banish slates from schoolrooms.

PETROLEUM AND ITS PRODUCTS.

AT a recent meeting of the Rochester, N. Y., Academy of Science, a paper was read by Mr. F. L. King, who, after giving a brief history of petroleum from its first discovery by the ancients, and the localities in which it is found in this country, spoke as follows, as reported by the *Rochester Morning Herald:*

In 1852 some attention was directed in different parts to the subject of petroleum or rock oil, and search was made for it in various directions. Among other places Oil Creek became the object of attention, and a company was formed to procure oil from an oil spring, the existence of which had become known to a large number of persons. The company was known as the Pennsylvania Rock Oil Company, Professor Silliman being at its head. Their operations were confined to collecting the surface oil until in 1858 Colonel E. L. Drake, of New Haven, Conn., was engaged to visit the valley and set about drilling a well on Watson's Flats, about a mile and a half below Titusville. The first well was unsuccessful and another was sunk. This was a success in August of 1859, when the drill struck an oil cavity at a depth of 69½ feet, and on the tools being drawn the oil rose to within five inches of the surface. It was pumped off and yielded at first 400 and afterward 1,000 gallons per day.

Thus was the beginning of a great industry, which now ranks third in our exports; which, according to Stowell's report of January 24, 1883, places the production for 1882 at 30,053,500 barrels; the export, 15,281,507 barrels, and home trade, 6,895,085 barrels; the daily average production, 82,303 barrels. By taking the average demand for last year he makes it appear that the over-production is now but 487 barrels daily. The largest oil fields of Pennsylvania are now centered around Bradford, of which this is a sample. It has an average gravity of 43 degrees. It contains a large amount of paraffine, and congeals at about 40 degrees. It has no fire test, being as inflammable as benzine. This is the oil that is quoted in the papers daily, and it is worth today about ninety cents per barrel. It is the general oil of commerce, and is the crude from which most refined and some lubricating oils are manufactured. Smith's Ferry, in the extreme western part of Pennsylvania, produces the lightest colored as well as the lightest gravity petroleum, being 51½ gravity, and is about the same as Bradford both for cold and fire test. It is very valuable for manufacturing light colored lubricating oils, is worth $1.00 per barrel. Franklin, which lies between Bradford and Smith's Ferry, produces the heavy oil of Pennsylvania, is black in color, has a gravity of 31°, flows below zero, and has a fire test of 200 and is worth $5.50 per barrel. All of the best lubricating oils are manufactured from this crude. The operation of distilling petroleum is conducted in large cylindrical retorts or stills, varying in capacity from 50 to 3,000 barrels, connected with a coil of wrought iron pipes submerged in a tank of water for the purpose of condensing the vapors as they arise from the stills. The first product of distillation is gases: at ordinary temperature they pass through the coils and escape without being condensed.

In order to collect these very light distillates ice and salt are packed around the condensing pipes or else condensed by means of a force pump. This product is called chymogine and is of 110° gravity. The next distillate would be rhigolene, of an average gravity of 95°, and is used as an anæsthetic. The evaporation of this fluid is so rapid at ordinary temperatures that it will depress the mercury in a Fahrenheit thermometer to 19° below zero in twenty seconds. The third distillate would be gasoline, of an average gravity of 87°, and is used in gas machines. The fourth distillate is naphtha, of an average gravity of 74°, and is used for street lamps and vapor burners. The fifth distillate is benzine, of 64° gravity, and has a variety of uses. The sixth distillate being too heavy for refined or kerosene oil, is run into what is known as the stop tank. The seventh distillate, from 58° to 50°, is for refined oil, of 100 flash test. The eighth distillate, from 50° to 42° gravity, is for 150 water white oil, which is also sold under fancy brands, such as lunar, astral, electric light, etc. The ninth distillate, from 42° to 38°, is united with the seventh distillate for 100 flash test refined oil. The ninth distillate is a very heavy paraffine, and being too heavy for refined oil, is pumped into the stop tank along with the sixth distillate, after which it is pumped back into the still along with a fresh supply of crude and again distilled. The eleventh product is the tar or residuum which remains in the still.

In actual practice one refinery does not make the entire list of distillates. Most, however, make the benzine as well as refined oil, while the lighter distillates are disposed of to others for purification—who make a specialty of these lighter products, which are redistilled by means of steam, which deodorizes them; but the heavier ones, naphtha and benzine, to make them sweeter, are thoroughly agitated in an upright lead-lined tank called the agitator, with a certain per cent. of sulphuric acid. The agitation is effected by blowing air through the liquid by means of a pipe extending nearly to the bottom of the tank, by which means the acid removes any remaining offensive odors and makes oil light in color.

After agitating and standing there separates a dark red, tanny liquid which is drawn off from the cone-shaped base of the agitator. This is what is known as sludge or spent acid, and is sold to manufacturers of fertilizer. The oil is then washed with alkali, then with water, which removes any remaining acid. The oil is then drawn off in shallow tanks, where it is bleached by the sun, after which it is ready for market. The 100 degree flash and water white oil has to undergo the same treatment with acid and alkali. All refined oil sold in this State has to stand a flash test of 100 degrees, according to this instrument.

Prior to August, 1882, the oil was required to stand 100 degrees fire test according to the Taglifur tester. A good refined oil is generally of 45 degrees gravity, having a chill test of twenty-five degrees, and burns not less than one ounce per hour, and flame should not fall more than ⅛ or $\frac{3}{16}$ inches in eight hours' burning. Of course the water white oil cut from 50 degrees to 42 degrees, which is, so to speak, the cream of the oil, the quality is much better, being about 47 degrees gravity, and will not chill at zero, is of 150 fire test by the Taglifur tester and from 105 degrees to 110 degrees flash by the State tester, and burns from 1½ to 1¾ ounces per hour; the flame should not fall more than from $\frac{1}{16}$ to ⅛ inches in eight hours' burning.

The tar or residuum which remains in the still is drawn off into smaller stills of from ten to fifteen barrels capacity, connected with a condenser same as still first described. The distillation is carried on in these stills until nothing but a coke or sort of asphalt remains, which has to be chipped out with a coal chisel. The principal product from this distillation is crude paraffine oil, but in some refineries where they do not reduce their tar too low in the first distillation, they obtain a 300 degree fire test burning oil as well as the crude paraffine oil. This 300 fire test burning oil is required by the United States government to be burned in all mail cars. It is sold under the brands of mineral seal and mineral sperm.

The crude paraffine oil obtained in this second distillation is first treated with acid, then distilled with caustic soda present in the still, the product being mostly dense paraffine oil. This is placed in wooden barrels in ice houses, where it remains for from seven to ten days, during which time the paraffine wax crystallizes, so that the mass retains the form of the barrels when they are removed. It is now put into strong cloth bags which are placed one above the other with sheets of iron between them, and when submitted to heavy pressure yields, crude scale paraffine wax remaining in the bags and heavy oil is pressed out, which is the paraffine oil sold for lubricating purposes and is most adapted to light, rapid running machinery, such as spindles in cotton mills. That which remains in the bags is the same as this sample.

This is further refined by repeated solutions in naphtha recrystallizing and pressing until it is perfectly white and pure, ready for market, but a latter process is to heat up and filter through animal charcoal, through which process this sample has been and is used principally for candles, but has a variety of other uses too numerous to mention. There is an earthen wax similar to the crude paraffine wax called ozokerite, mined in Austria, and is used for manufacturing candles; it is also found in Texas, California, and large deposits of it are found in Utah. In manufacturing heavy lubricating oils the same style still is principally used as the one first mentioned, also the same distillates are obtained, crude naphtha, benzine, refined oil, etc., but the oil is not reduced so low or to so small a quantity in the still as is done in distilling refined oil.

You will understand in running lubricating stills the product to be obtained is that which remains in the still. A lubricating oil of any desired fire test, cold test, or gravity can be obtained by drawing the fires after running a specified time. For instance, we wish an oil same as this sample, which is 380 fire test, 28½ gravity, and 20 cold test, we would keep the fires going under the stills, until the time specified, when the fires are drawn and still allowed to cool, after which the oil is barreled and ready for market. This oil is used for lubricating railroad coaches, shafting, etc., but if we wish to obtain a very nice engine oil we would pump this oil from the still into the filtering room, where it would be filtered through animal charcoal, after which we would have this light colored oil, which is considered equal to lard and better than sperm oil as a lubricant. This, as well as all other mineral oils, will not corrode or eat the bearings or surfaces where it may be applied, as animal oils do. If we were to continue the distillation on instead of stopping for this coach or engine oil, we would have this heavy oil, which will not flow below 75°, has a gravity of 27, and fire test of 500. This is used as a cylinder or valve oil for stationary engines. It is sometimes filtered through animal charcoal; the first product through the filter is perfectly white, the second is a little darker and continues to darken until we obtain the third product, which is sold as cosmoline, vaseline, petroline, etc., and is used in its plain state as an unalterable base for all ointments.

It has no affinity whatever for oxygen or moisture and will never decompose, ferment, or become rancid in any climate or temperature. It is a wonderful remedial agent for every species of soreness and inflammation. It is also compounded into camphor ice, cold cream, toilet soap, and cough drops. Our next product through the filter is this oil, which is a filtered cylinder oil for stationary engines. Were we to continue the distillation in the still longer, instead of stopping for this cylinder oil and cosmoline product, we would obtain this oil, which is the heaviest product of petroleum. It has a fire test of between 650° and 700°, a gravity of 23½, and flows at 45°. This is used as a locomotive cylinder oil, for tempering steel, etc.

ON BRAIN-WORK AND HAND-WORK.

By R. M. N.

IT may seem presumptuous in me to take up a subject which has been ably dealt with some years back in the "Journal of Science," by occasion of Dr. Beard's treatise on the "Longevity of Brain-Workers." Still it appears to me that the last word on this topic has not yet been said. Certain points, both of distinction and of resemblance, seem to have been overlooked as well by reviewer as by author, and certain of the conclusions drawn are at least open to question.

I may perhaps be allowed to put the opening question, What is work? The common reply is, "Any pursuit by which a man earns or attempts to earn a livelihood, and to accumulate wealth." This definition is the more to be regretted because it cherishes, or rather begets, the vulgar error that all persons who do not aim at the accumulation of wealth are "idlers." In point of fact such men may be doing far greater services to the world than the most diligent and successful votary of a trade or a profession. Darwin, having a competency, was therewith content. To him, and to others of kindred minds, the opportunity of devoting his whole life to the search after scientific truth was a boon immeasurably higher than any conceivable amount of wealth. Shall we call him an idler? Nor is Science the only field which opens splendid prospects to men of independent means. Art, literature, philanthropy, have all their departments, unremunerative in a commercial point of view, or at least not directly remunerative, and for all these cultivators are wanted. Therefore, reversing the advice given by routine moralists, I would say to wealthy young men of ability, "Do not take up any trade, business, or profession, but do some of the world's unpaid work. Leave money-making to those who have no other option, and be searchers for truth and beauty." Every one who follows this advice will contribute something to show the world that the race for wealth is not the only pursuit worthy of a rational being. I should define work as the conscious systematic application of mind or body to any definite purpose.

I said "of mind or body." Perhaps the expression may sound old-fashioned; so to avoid grating on the nerves of a monistic world I will say "of brain or muscle." But can we draw a sharp, well-defined boundary line between brain-work and muscle-work? Recent investigations into the functions of the brain show that it has the task of directing and co-ordinating muscular effort. The athlete, or say the musical performer, has not merely to strengthen his muscles and acquire flexibility of arm, hand, and finger; his exercises serve at the same time to develop and perfect those regions of the brain by which the muscles in question are actuated and co-ordinated.

Prof. Du Bois Reymond, in his admirable treatise on

"Exercise" (reviewed some time ago in the "Journal of Science"), contends that "bodily exercises are not merely muscle-gymnastics, but also nerve-gymnastics," and that practice in the movements of the limbs is "essentially exercise of the central nerve-system." Hence muscle-work which is not at the same time brain-work is a chimera which has no existence. But it will now be asked, Is there any brain-work without muscle-work? Undoubtedly; we may see phenomena, we may reason upon them, and come to a conclusion concerning their nature without any muscular action at all. But if we even wish to write down our results, or to tell them to a friend, some muscular action, small though it be, is needed. Or we wish to go further: not content with merely observing the phenomena which chance brings before our eyes, we go forth in search of facts. Here muscular work is blended with brain-work. A step further: We wish to put definite questions to Nature, to perform physical, chemical, or physiological experiments. In all these cases the hand has to be the inseparable companion of the brain. The efficiency of the one will not compensate for inefficiency in the other. Now, the work of the experimentalist rarely requires great strength, but it invariably stands in need of delicacy, nicety of touch and movement, bodily or, if you will, muscular attributes to be reached only by training.

It is the same in the fine arts. The painter needs not merely an exquisite perfection of form and color, an instinctive—as it appears to outsiders—appreciation of their relations and harmonies; unless he possesses in addition to all this the requisite nicety of touch, he must fail to embody in visible form the conceptions present in his brain. Precisely the same is it with the musician. The orator and the actor must also, in addition to their mere mental gifts, have vocal organs thoroughly developed and disciplined. Thus we see that in the highest walks of science and art, brain-work and muscle-work exist, I might say, in a state of interpenetration.

Again, at a work-table in Y—— Street, sits a microscopist, carefully studying the peculiarities of a newly detected microbion, or dissecting the larva of the Phylloxera. What is he? Brain-worker, or muscle-worker? You pronounce him a brain-worker; his brain, in your opinion, doing the larger—the essential—part of his task. So be it. I convey you to X—— Street, where at another work-table sits a microscope-maker. He is accurately adjusting an objective of high power. What is he? Like the user of the microscope just mentioned, he requires the utmost delicacy of touch, the highest manipulative skill. Like the microscopist, also, his brain performs the essential part of the task. But you will probably call him a hand-worker or muscle-worker, because he is a mechanic!

Surely, then, we must admit that there is no hard and fast boundary between the brain-worker and the muscle-worker. There is no muscle-work without brain-work; there is little brain work of a high order without muscle-work.

There are, however, gradations. There are kinds of muscle-work so simple, so monotonous, or uniform in their character, that they are, with very little practice, performed automatically, with no conscious effort of the brain. Such, for instance, is the work of the agricultural laborer in digging, mowing, thrashing, etc., or of the hodman carrying bricks and mortar up a ladder. All such work, it is generally found, can be performed by means of machinery. Perhaps this may enable us to find a definition, or rather a limit, for muscle-work.

I must now ask what classes of society can rank as brain-workers. Dr. Beard seems to include here clergymen, lawyers, physicians, merchants, scientists, and men of letters. He does not make any mention of artists, teachers of different branches of knowledge, manufacturers, etc. Now, if the merchant, the man who distributes, fetches and carries, is to rank as a brain-worker, surely must the producer, who much more frequently originates out of his own mind something new to the world. We may also ask, Does the term merchant include the retail dealer, the clerk, and the commercial assistant? If so, we find the brain-working class re-enforced by a number of persons who certainly have little need for muscular exertion, but little also for brain-work, and many of whose tasks and duties might be performed by machinery. Again, where are we to place the speculator, the gambler, and the forger? Muscle-workers they are only to a very small extent, though the forger requires a wonderful amount of manipulative skill. He must, however, be regarded as a doomed species, since the Nesbit patent safety-check carries in it the germs of his destruction.

It becomes very difficult to say with accuracy who are to be classed as brain-workers, and who as muscle-workers, and, still more, who are to be referred to Dr. Beard's third class, "those who follow occupations that call both muscle and brain into exercise." This class, as I have endeavored to show, includes almost every one who works at all. Until we are able to furnish a correct classification of mankind as brain-workers and muscle-workers, it will be very difficult to enunciate any true and valuable proposition concerning either group.

Twenty years ago, Dr. Beard laid down among others the following set of propositions: That the brain-working classes—clergymen, lawyers, physicians, merchants, scientists, and men of letters—live very much longer than the muscle-working classes. That the greatest and hardest brain-workers of history have lived longer on the average than brain workers of ordinary ability and industry. That clergymen are longer-lived than any other great class of brain-workers.

The first of these propositions admits of statistical proof or disproof. The life-lengths of the classes of men above mentioned can be ascertained, and their average duration compared with the mean length of life prevalent in their times and countries. But is the superior longevity of these classes due to the fact that they are brain-workers, or must it not be traced to a complication of causes? If brain-work is *per se* salutary and conducive to long life—which I do not deny—and if, as we may gather from Dr. Beard's second proposition here given, its beneficial influence is proportionate to its intensity, we should find the man whose brain-work is devoted to origination stand highest in the list. As such I should undoubtedly rank discoverers in science, inventors in the industrial arts, poets, musical composers, and painters (not of portraits). But the third proposition entirely clashes with this conclusion. Dr. Beard tells us that of all brain-workers, clergymen are the most long-lived. Yet they can scarcely be called the hardest brain-workers, since what is demanded from them is not origination, creation, but expression. If a clergyman initiates new doctrines, he is in danger of becoming a heretic. He is expressly forbidden to do what is expressly demanded from the man of science or the author. Indeed, till a comparatively recent date, the life of an English country clergyman has always been considered as one of the easiest of all careers, making no heavy demands either upon brain or muscle.

Indeed, Dr. Beard, when he undertakes a formal explanation of the great longevity of the clergy, makes some very important concessions. He remarks that "their calling admits of a wide variety of toil."—"In their manifold duties their whole nature is exercised."—"Public speaking, when not carried to the extreme of exhaustion, is the best form of gymnastics that is known." Dr. Beard here admits what I also maintain, that the most healthful work is that which duly and harmoniously calls into play all the various faculties of a man. Brain-work is in itself good and wholesome—undoubtedly better than pursuits which exercise the muscles alone, leaving certain regions of the nervous centers inactive. But it is still inferior to work which exercises the entire system. Whatever calling effects this most thoroughly and equally will be the ideal vocation. But it may be said that the duties of a physician call a wide circle of powers into play. Why, then, is he less long-lived than the clergyman? In his case there is wanting any physical exercise which may take the place of public speaking, and he is more exposed to death from contact with malignant disease.

As an instance of the especial benefit to be derived from an exercise of the whole system, I may glance at the lessons to be gathered from the experience of exploring expeditions in unhealthy countries. The first to succumb are porters, guides, muleteers, private soldiers and sailors, etc. Next come military and naval officers, while the doctor, the botanist, the geologist, etc., hold out to the last, their sole advantage being a more thorough exercise of the whole system, muscle, and brain alike.

Dr. Beard gives another reason for the longevity of the clergy—their comparative freedom from anxiety. This is the critical point to decide whether brain-work shall be healthful or harmful. Let a man work knowing that his livelihood is secure—that it is indifferent whether he completes any given task this month or this time six months—and no amount of study will harm him. But tell him that he must complete some task by a given date under penalty of dismissal, or that his prospects in life depend on his passing an examination better than a score of competitors, and the probability is that his studies will bring on softening of the brain, heart diseases, or perhaps Bright's disease.

Dr. Beard formally admits that "worry is the one great shortener of life under civilization, and, of all forms of worry, financial is the most frequent and the most distressing. "Hence the differences between his views and mine are very much smoothed over, and we must take in a "Pickwickian sense" his declaration elsewhere that "brain-work is the highest of all antidotes to worry."

He brings forward yet another reason for the longevity of clergymen—"their superior temperance and morality." That such superiority, if it exists, will have an influence in favor of health and long life, I readily admit. But it is very doubtful whether they are in this respect superior to other brain-workers. In the career of the scientist mutinous passions are simply crowded out. For him the struggles with temptation, of which the ethicists tell us, have simply no existence. How it may be among those brain-workers who move in a more emotional sphere, I cannot presume to say.

Dr. Beard's contention that the brain-worker is, as a class, happier than the muscle-worker is very questionable. He asks, "Where is the hod carrier that finds joy in going up and down a ladder, and, from the foundation of the world until now, how many have been known to persevere in ditch-digging or sewer-laying, or in any mechanical or manual calling whatsoever, after the attainment of independence?" Such persons, I think, might be found. Many of these manual occupations would, as far as I can judge, seem happier than a life spent at the merchant's desk or at the exchange. If the man of business "continues to work in his special calling long after the necessity has ceased," it is because he has been trained to believe that accumulation of wealth is the whole duty of man. "Nearly all the money of the world," says Dr. Beard, "is in the hands of brain-workers." This may be true; yet, at the same time, many of the hardest and most capable brain-workers rank among the very poorest. Young men are now warned by their friends to avoid the highest class of brain-work, and even to shun the learned professions, "because they do not pay." I meet with books containing the records of original research, yet for which the author has received less than the wages of a stone-breaker for the time employed. I meet with inventions which ruin the inventor and enrich his followers. Verily, the manual laborer has scant cause to envy the brain-worker.—*Journal of Science.*

THE RIGHTS OF THE INSANE.

By C. H. HUGHES, M.D., of St. Louis,* late Superintendent Missouri State Lunatic Asylum, Honorary Member British Medico-Psychological Association.

THE age in which we live is pre-eminently regardful of the rights of man. The corner-stone of our political fabric was laid in the professed sanctity of personal rights. Constitutions were and are framed, and statutes enacted, for the protection of the weak against the possible encroachments of the strong. The right to life, liberty, and the pursuit of happiness is the recognized right of all sane persons, and law cannot take from any citizen that which is not absolutely essential to his own or the community's welfare. The citizen's house is his castle; the law cannot enter it, "the king cannot enter it," and in this country the voice of the people is king, unless it be to protect him in some of those rights of person or of the community connected with individual affliction.

In an age and country such as ours, the very weakness of mental disease is its safeguard, just as the weakness of woman secures to her that chivalrous protection in society which her own frail arms could not obtain for her, and should be always. And when, mentally maimed, a citizen falls in the battle of life, the government—national or State—cares for the fallen one as though he were a soldier, fallen in defense of his country's flag. Moral duty and philanthropic patriotism combine to lift up the fallen, and "bind up his wounds."

No fault can well be found with the manner in which municipal government discharges its plain duty of caring for its insane in hospitals. In fact, so liberally have State and national governments housed these unfortunates, that some have regarded the substantial and enduring buildings erected for them as too costly and palatial in character. These palaces are the monuments which a philanthropic age erects commemorative of its charitable purpose toward those most afflicted of the "children of affliction;" serving to show what will further be done for these helpless ones, when communities are fully awakened to all of their needs and rights (and the necessities of their affliction are their rights).

Among the other rights of the insane, not yet fully regarded by the State, which are so obvious as to require only a plain statement of them to carry conviction, are the following:

First, to such protection against themselves, and the consequences of their malady, as will secure to them recovery, where recovery is possible, by care and treatment in the incipiency of their disease.

Under this is the right to have that prompt surveillance and treatment for himself which, in his best estate, he would demand for his similarly afflicted friend. The abstract right to liberty is subsidiary to that of the insane man's welfare and happiness.

It is the duty of the State to inquire into the existence of incipient mental disease, and avert its culmination in consequences disastrous to the afflicted one and others, because it is a right which the strong owes to the weak, which a protective government owes to its helpless citizens.

In thus protecting the insane, the State incidentally protects the community against the consequences of insanity. The rights of the insane and the duty of the State here go together; and the right of every community to be quarantined against the often disastrous consequences of unguarded insanity likewise suggests the obvious duty of the State.

Out of this right of the insane to have that attention from the State which their malady requires, grows the necessity of State inquiry, by competent medical commission, into the existence of incipient and advanced insanity, outside of the asylums, and such surveillance as will secure to the insane of every grade, in every community, their right to proper medical and personal care and guardianship against self-neglect or possible indifference of their families or near friends. Every consideration combines to strengthen the plea for the rights of the insane to the paternal watchfulness, and, where necessary, the care of the State, not alone after they have found lodgment, by judicial process, in the State institutions, or may have been declared "dangerous to themselves or others," by a medical inquiry, but in that stage of their malady when there is a hope of averting the culmination of the ultimate dire consequences of the disease from themselves and others.

The marital rights of the insane should also be regulated as well as guarded. Insane persons should receive such protection from the law as they, were they sane enough to realize consequences, would ask for themselves; and posterity should be guarded against the fatal heritage of unstable organisms, the natural consequence of the marriage of the insane. No virile lunatic should be permitted to marry. No insane woman should be allowed by law to bring into the world a mentally maimed or dwarfed progeny (wherever it can be prevented) to become an ultimate burden upon the State, and add to the already large sum of human misery and woe.

Marriage of all insane persons at certain ages should be interdicted by law, and the victims also of such diseases as entail insanity or epilepsia should also be forbidden to enter into matrimony before the sterile time. In behalf of the rights of the insane, who would not wish to have a maimed offspring, if, under the dominion of their right reason, it should be lawful for proper persons to forbid such disastrous bans, and the duty of the State to prevent them.

It is a terrible thing for the State to tacitly consent to such deterioration of the race as is caused by such marriages; and duty to humanity, sane and insane, demands repressive legislation. No "pestilence that ever walked in darkness, or destruction that has wasted at noon-day," ever called more loudly for State intervention against their spread than the destructive heritage of the neuropathic diathesis calls for the concern of the State. Its evil influences are all about us, even more disastrous than any plague or pestilence, afflicting the humblest citizen, as well as the highest, and their posterity.

Discussion of the marital relations of the insane is not the purpose of this paper. To exhaust the subject would require more space and time than this section has at its disposal.

Under what circumstances the rights of the insane to retain the marriage relation inviolate should be held sacred, need not be here discussed in view of what has been said. Their rights are better secured by interdiction than by divorce; but the circumstances under which divorce ought to be granted we prefer to leave to inference rather than enter on its discussion.

We turn now to briefly notice the rights of the insane before the law in civil and criminal trials.

Insanity is conceded to be a disease of the brain in which the mind is morbidly affected in its natural manifestation, by which the insane person is made incapable of conducting his cause as a sane person would, or as he would in his rational mental estate. It is on the basis of disease that the insane should have rights before the law different from those accorded the sane. Their rights are not all secured to them when they are tried exclusively in the same manner as the sane are. Disease of the mind, if it exists, must be established in the same manner as any other fact.

Now, a just regard for the rights of the insane as mentally diseased persons, and consequently more or less crippled and perverted in their mental operations, demands that we should accord to them a medical examination after medical methods, into the question of the disease; and that courts should aid in the inquiry by every means known to them or suggested by medical science, as calculated to elicit the "truth, the whole truth, and nothing but the truth" respecting the existence or non-existence of disease.

It is obvious, therefore, that the hypothetical case, without ample personal examination by medical men, is not full justice to the really insane, while it may, and often does, answer the purpose of casting doubt on the jury's mind respecting the sanity of really sane persons, thus aiding the unworthy to escape the consequences of crime, while it does not give the best chance to the innocent, by reason of mental disease, to fully establish the existence of disease, or, rather, to have their disease established for them. The really insane should not have their chances of vindication imperiled by possible medical deficiencies of counsel. Defending counsel may fail, through ignorance of essential symptoms, to so present them as to convince medical experts, and yet the prisoner may be insane, and his insanity may be susceptible of proof if sought out by medical men by medical methods.

As the determination of the question of disease in general by an ordinary jury trial must obviously be very unsatisfac-

* Read before the American Medical Association, St. Paul, June, 1882.—*Alienist and Neurologist.*

tory and unjust to the afflicted, so must such an inquiry in special cases of mental disease sometimes jeopardize the interests of the really insane, as in times of great public excitement, and in localities where prejudice has grown up against the plea by reason of previous escapes of the guilty upon it, through misuse and misapplication of the hypothetical case. At such times and occasions it would seem only just to the insane for the court to order medical expert commissions, selected from remote distances, to deliberate upon and determine the question of the prisoner's mental status from personal examination and all obtainable evidence.

Finally, a proper regard for the rights of the insane before the law should secure for them rulings by courts in accordance with the nature of their malady, as shown by clinical experience, rather than in accordance with those theoretical conceptions of courts which are often judicial misconceptions of insanity. Such judicial rulings as declare that evidence of the existence of the knowledge of right and wrong in the mind is evidence of responsibility, regardless of the overmastering influences of those resistless morbid impulsions which are common to and characteristic of certain forms and phases of mental aberration, do violence to the sacred rights of the insane, to that just protection due to the helplessness of disease from the rational and powerful to protect or crush them. Insanity is a law unto itself, and is no respecter of the theoretical boundaries with which jurists have sought to circumscribe it. We know from observation of this malady that an abstract knowledge of right and wrong may exist in a mind rendered powerless, by reason of overmastering disease, to resist the wrong and morbid impulsion, as may be demonstrated, in many cases, in asylums for the insane. A really insane person is entitled to judicial rulings in accordance with the facts and truth of his malady, whether it conflict or conform with non-medical conceptions of what the nature of insanity ought to be.

A subsidiary right of the insane is to have the State provide criminal lunatic asylums, in order that the rights of the insane may not be put in jeopardy by the just fear in the public mind of having insane murderers and others go free. An insane murderer, with certain exceptions, notably those of temporary puerperal mania, should be under the State's surveillance for life, and law should secure to the lunatic and the community this protection against the possible consequences of disease. Such security to society incidentally guards the insane man in his rights, and makes the chances for equal and exact justice, when insanity is pleaded in excuse for crime, much more secure.

The last right of the insane, but not the least, that I would here mention, is the right to medical inquiry, in lieu of the ordinary trial by jury, into the question of their insanity, before committing them to asylum care and custody, such an inquiry and so conducted as might not aggravate the sick man's malady by undue causes of irritation or needless publicity, or jeopardize his chances of timely hospital treatment by a verdict of "not insane enough for hospital treatment, because not yet dangerous to self or others, or a disturber of the public peace;" such a thorough, unimpassioned medical inquiry as would certainly reach the true nature and needs of his malady—and such an inquiry is best secured by men competent from experience to investigate the nature of mental disease.

No such construction of the "due process of law," guaranteed to any one deprived of liberty should be made as to deprive a mentally diseased man of a thorough medical inquiry, conducted in accordance with the nature and demands of his disease, in preference to the ordinary "jury of" the insane man's "peers."

A last incidental right of the insane is to have proper instruction, in regard to insanity, provided for in the medical schools, and we make this demand for them: That henceforth no medical college shall be chartered that does not provide a chair of psychiatry. The true friends of the insane are in the profession, and its members should understand them.

LOUIS MAICHE.

LOUIS MAICHE was born on the 22d of June, 1843, at Mans, and although not yet forty years of age, has accomplished a work that would suffice to render illustrious an entire existence.

Endowed with great powers of observation and a marvelous perspicacity, he applied himself, while yet a youth, to the study of the phenomena of nature, searching out their causes, analyzing their effects, and ceasing one investigation only to take up another, until some application in physics or mechanics gave the precocious inventor a legitimate satisfaction. "Moreover," he tells us, "I enjoyed the most unlimited liberty with my parents, who never threw an obstacle in the way of my taste for researches. To this I owe, undoubtedly, the success which has almost always crowned my investigating studies."

The inventor, as modest by nature as he is bold in his conceptions, forgot to add that it was to his indefatigable labor, to his personal worth, that he owes the results that he has achieved, and the reward for which will not have to be waited for very long.

We could not enumerate in so short a note as this the object of the hundred or more patented inventions which are due to Mr. Maiche, and we shall therefore cite some of those that are the most remarkable or the most useful to commerce and the industries. These are:

The process for extracting starch by the application of centrifugal force—a system which was quickly adopted by all starch factories.

The electro-chemical bronzing of zinc, and the gilding of aluminum; and a permanent boiler feed, an apparatus of extreme simplicity, by means of which water is kept at a constant level in the generator, and the necessity for the use of which was so fearfully shown by the late Marnaval accident.

In the department of electricity, Mr. Maiche's productions are as varied as they are ingenious and practical.

Every one knows at present the economical pile which bears his name, and we do not think we will be stepping aside from the truth when we say that, as soon as its numerous advantages shall be known to the public, it will everywhere be substituted for its congeners, not excluding even the Leclanché pile, that is so generally liked because of its convenience.

As well known, the Maiche pile is particularly applicable to telegraphy, telephony, call-bells, railroad signals, etc. Its duration may be considered as *indefinite*. A single element has actuated a vibrating bell for eighteen months without any perceptible wear on the zincs, and with a lowering of about only one centimeter of the water in the receptacle. This fact will not seem so extraordinary if we recall the reactions that occur in this valuable apparatus, which borrows from the surrounding air the motion that it converts into electricity.

Among other happy electrical devices of Mr. Maiche, we may cite, *en passant:*

A telephonic condenser for transmitting speech, and one of the most original of inventions;

A radiometric relay—an apparatus of great sensitiveness, in which the rays projected by a Thomson galvanometer produce a movement of parts that bring about a contact which closes the circuit of a local pile which actuates the receiver;

A very sensitive radiometric microphone;

One of the simplest of processes for renewing, by means of a machine of any other source of electricity, used up piles, and making them, after a manner, reservoirs of electricity;

A telegraphic system adapted for the renewal of currents that are too feeble through effects of induction; etc., etc.

But where Mr. Maiche has displayed all his powers of conception, all his talent as an inventor, is in his creation of the electrophone at an epoch at which the Gower apparatus seemed to have reached the limit of further progress. Since then, Mr. Maiche has brought the apparatus to such a degree of perfection that no other known telephonic or microphonic apparatus can compare with it. Among the successive modifications that have been introduced into the structure and the connections of this apparatus, we may cite the substitution of three carbon spheres, arranged for quantity, for the 20, 30, or 40 contacts that were at first given by half that number of crayons. Through this arrangement, speech from a distance becomes much clearer, and all the inflexions of the voice are much more faithfully reproduced. We may note also the addition of a secondary ground wire, which suppresses all resonance in the receiver, and re-enforces the sounds on their arrival.

At all distances, and with a pile of four or five elements, the electrophone reproduces the sounds transmitted with the same clearness as when it is used between a few stories in the same house. On another hand, the experiments performed with it over a cable of the submarine company between Calais and Dover gave the most brilliant results.

LOUIS MAICHE.

Finally, Mr. Maiche's most recent invention is a mode of rapidly drying solid materials in a relative vacuum, at a low temperature and under a low pressure. The economic advantages of the process seem to be so important that we are glad to call the attention of our readers to it.—*L'Electricite.*

EYE-GLASSES.

FOUR out of every five persons who wear glasses wear eye-glasses. The fifth wears spectacles. Ninety-nine in every hundred who consult either oculist or optician are advised to wear spectacles. As a rule, four-fifths of them refuse to accept the advice given. The only reason given is that eye-glasses look more stylish than spectacles. The reason given is that "the glasses fit my eyes better than any spectacles I could find." Some foolish young ladies and gentlemen adopt eye-glasses because they think it gives them a *distingué* appearance. Their use gives the wearer an opportunity to attach to the costume a bit of jewelry they could not otherwise sport—a delicate gold chain, which may be worn so that the ear is made a resting-place for the connecting link between eye-glass and vest or dress. With this class the eye glass is of no earthly use, except as a means of injuring the eye. Such glasses have no magnifying power, and are as valueless to the weak or deformed eye as the single eye-glass. Single glasses are worn only by Englishmen, Anglo-maniacs, and idiots. The party who wears one—it is always a man—may be at once set down as a snob. There will be no mistake. A sane man needs a single eye-glass about as much as a cat needs two tails, or as a tramp needs a Saratoga trunk. As a few "men about town" wear the single eye-glass and a few actors wear them on the stage, they have attained a certain amount of popularity, mainly among the classes mentioned. The idiots include the "dudes." So popular have eye-glasses become among those who are compelled to wear glasses to aid defective sight that the use of spectacles is confined mainly to elderly people and to boys and girls. The fact that young children who are troubled with affections of the eye invariably wear spectacles is known to every observing man. The fact carries with it a lesson. That is, that the child does what the oculist tells it or its parents to do. The person of maturer years, unless he or she is blessed with an unusual quantity of common sense, doesn't follow instructions. He or she generally disregards orders and wears the eye-glasses instead of spectacles. Fashion's decrees that the former are the more stylish overrule advice of oculist or physician. The advice is given because the spectacle is very much better in every way for the person afflicted with any disease of the eye. They are easier to wear, and do not injure the nose in any way, which the pinching of the eye-glass frame does sometimes. The frame of the spectacle is desirable because it holds the glass firmly in its place. The eye-glass is in a constant state of unrest. As a result, particularly where the glass is either a double convex or double concave lens, the magnifying power is constantly varying. The variation is slight, to be sure, but it exists to a sufficient degree to cause injury to the eye. That is one of the reasons why people who wear eye-glasses find it necessary to purchase new glasses of constantly increasing power. They generally ascribe this result to old age. It isn't advance in years so much as it is eye-glasses that causes the trouble.

Fashions change in eye-glasses and spectacles as they do in all other articles of personal use or adornment. It is even within a quarter of a century that eye-glasses became so extremely popular. Five years will cover the period within which they have come into common use, and have virtually driven spectacles out of the field. A half century ago the eye-glass in the shape of a lorgnette was fashionable among people who were not obliged to wear spectacles constantly. They had to be held to the eyes, and were not intended to rest on the nose without being held in place. The lorgnette has again come into fashion. The finest have the glasses set in heavy gold frames, the glasses being connected by a stiff band instead of by a spring. The glasses shut like a knife into a handle of tortoise shell, horn, or gold, these handles being sometimes elaborately decorated. In the matter of frames, both for eye-glasses and spectacles, gold has gone out of fashion, in a measure, and tortoise shell frames for eye-glasses and fine steel for spectacles are the fashionable material. There is reason for the popularity of tortoise shell. It is the cleanest and least objectionable material ever used for the purpose. So great has the demand for shell become for use in combs and in other toilet articles and knicknacks, that the supply does not begin to equal the demand. The price has more than quadrupled during the past five years. For this reason rubber, horn, and celluloid have been pressed into service for use in frames. None have satisfactorily filled the bill, however. The unpopularity of celluloid may be explained in this way.

A gentleman who possessed a pair of eye-glasses set in a celluloid frame was addicted to smoking. To his eye-glasses was attached a cord, which was in turn fastened to its spring in his vest pin. The gentleman stood at a cigar stand lighting his cigar. The fire touched the eye-glass cord. The cord burned slowly until it reached the frame. Then the frame caused a very complete surprise to the gentleman by taking fire and burning up as completely as had the cord. Celluloid frames became unpopular with that gentleman from that time forward, and with his friends who had witnessed the scene or heard the story.

A peculiar thing about the material for frames is told by a large dealer in optical goods. Silver was at one time a very popular and fashionable material for frames and in some of the frames constructed a quarter of a century or more ago large quantities of the metal were used. This was especially the case with spectacle frames. When silver came into use in place of shin plasters as "current coin of the realm," silver went out of fashion in the spectacles wearing world as a material for frames. This was supposed to be due to the fact that people looked at a trade dollar, and saw the large quantity of silver it contained, and concluded that silver was not as valuable as they had supposed. So those who cared for display, even in spectacle frames, had their frames made of gold. Most of the frames used, both for spectacles and eye-glasses, especially the fine steel frames, which have come into fashion since the war, are imported from France and England. From those two countries also large quantities of completed glasses are imported—spectacles from England and eye glasses from France. English eye-glasses are too cumbersome for the American market.

Pebble is the best and most expensive material used in the construction of the glasses themselves. These are ground in a great variety of shapes to secure desired results, double concave and convex lenses, plano convex and plano concave, and periscopic being the commonest forms. The periscopic lenses are now considered the most desirable, as by the peculiar method of grinding the pebble or glass the desired result is obtained from almost any line of vision. Nowadays the lenses are frequently ground to order, the style of lens required and its strength being designated by the oculist, who very frequently in testing the eyes of his patient finds that different kinds of lenses are needed for each eye. The common kind of lenses used are what are known as the spherical glasses—that is, they are ground on a sphere. The lenses used in special cases, for peculiar diseases or deformities of vision, are generally ground on a drum, and are known in the trade as cylindrical glasses. The peculiar forms of glasses are made both of pebble and of the soft glass made expressly for this purpose. The pebble costs three times as much as the glass, and will last considerably more than three times as long. It is almost impossible to scratch the pebble, unless it be with another bit of pebble or a diamond. So hard is the pebble that bits of it are often used by glaziers to cut flint glass with, and it serves the purpose well. The glass used for lenses is made much softer than the common window glass, this being necessary in order to permit of the high polish necessary. Being so soft, the glass scratches easily, rubbing with a linen handkerchief being often sufficient to scratch and spoil a lens. The cheap grade of glasses that are hawked about the streets and sold in notion stores are generally made of a much cheaper quality of glass, and often of the common flint glass. They are sold at from $1.25 to $2 per dozen pair, and are commonly retailed at 25 cents a pair. It is this quality of goods that are colored and form the smoked, blue, green, and yellow glasses that are hawked about at the sea shore. The colored glasses are generally worn by people with weak eyes, or as a protection to the eyes from the reflection of the sun's rays from the water or the sands of the beach.

People who wear glasses because of defective eyesight rarely wear the colored glasses unless it be as a means of rest to the eyes. There are instances, however, where colored lenses have to be used, where weakness accompanies defective vision. In such cases the spectacle usually takes the form of a blinder; that is, there are two pairs of glasses—the pair worn, as usual, directly in front of the eye being supplemented by a pair which prevent the light from coming to the eye from the side. This form of spectacles with transparent glasses is sometimes used when the wearer wishes to avoid the necessity of carrying two pair of glasses. In such cases the second pair are attached to a frame by a

hinge. The single pair are used for reading, and when the side glasses are put down over the others, double power is obtained and the glasses are made fit for street use.

Pebbles were supposed until recently to have been a comparatively new material for use in spectacle lenses. This is not the fact, however, for there can now be seen in a Broadway store a pair of spectacles of unknown age, which came from China. The lenses are pebble according to all the tests used in determining pebble. The common test used is the tourmaline test. A bit of tourmaline is mounted in a circular frame. Between two such frames the glass to be tested is placed. If the lens is of glass, it will appear perfectly opaque when held up to the light. If of pebble, a faint yellowish light will show through, the pebble being so much more transparent than glass as to permit the passage of the rays of light through tourmaline and pebble.

The ordinary form of the lens is of course oval, but circular, octagonal, and even square lenses are fitted to frames to satisfy the caprice of the wearer. The elongated octagon is the commonest of the peculiar forms of glasses, and this is nearly always the shape of the glasses in lorgnettes. The Coquette is a French shape, which is vulgarly known as "the scoop." The lens is made in an almost hemispherical shape, and the advantages claimed for it are that it fits the eye more closely and also protects it. The lens is a clumsy looking affair, and will therefore never become popular in this country. People who travel much or who are employed on railroads, and wish to protect their eyes from flying cinders, prefer to use the common form of lens, to which is attached a frame with a network of very fine wire, which fits closely to the face, completely protecting both the eye and the lid. A somewhat common form of spectacles used nowadays is one with glasses of two different powers combined in the same lens. These are known as bifocal lenses. The upper half of this lens is of greater power than the lower. The object of the double lens is to enable a person to use the lower half while reading or writing, and the upper half to see at a distance. Such glasses are used to a considerable extent by ministers and other public speakers who speak from manuscript, and they are sometimes used by artists while sketching. In the latter case the artist sees the object he is sketching through the upper half of the glass, and does the transferring to paper while looking through the lower half. Another peculiar form of lens is the half oval. This has come to be known as the "pulpit eye" shape, because it is largely used by ministers. They can read their sermon through the glasses, and look over the top of them when looking at the congregation.

There has been, within the past few years, a complete change in the form of spectacle frames. The old hinged frames with pieces dropping back of the ears to hold the glasses in place have been abandoned, and the popular form is that which has the bow bent so that it bends about and firmly clasps the ear. The new form is popular not only because it is handier than the old, but because it insures the snug fitting of the glasses. Attempts have been made to get a different and modified frame for eye-glasses, but nothing satisfactory has as yet been devised. Lenses were made so that they would fit snugly against the nose, and the edge of the lens was made serrated so as to pinch against the flesh and hold the glasses in place. This plan did away with the use of a frame, and all the metal used was a bar which held the lenses together. While the plan operated well enough, it was not and never will be generally adopted, because it is an expensive plan. In case one glass became broken, it was necessary to have a new lens made specially to take its place, or else a new pair had to be purchased. This was too much of an annoyance and expense for even the swell young man, who wears eye-glasses "because they look so nobby, you know."—*N. Y. Times.*

THE VINEYARDS OF CALIFORNIA.

IN the Eastern cities and States generally, very little is thus far known of a great and growing industry springing up on the Pacific coast, in which the country at large should be greatly interested, and from which California should eventually derive a revenue and profit to compensate in a measure for its declining mining interests. The wine and grape business is not a new enterprise in California, extensive vineyards having been in operation several years, but only recently has an impetus been given to the business by the improved demand and better appreciation of the merits of a pure article. In the earlier stages of production the method and proper manipulation was not well understood, and many people formed a prejudice against California wines owing to their imperfect manufacture and crude condition, but experience and experiment has led to a more appropriate selection of soil better adapted to grape cultivation and the importation from Europe of experienced men skilled in the manipulation of the fruit. The result has been a wonderful improvement in the quality of California wine; and having that most desirable merit, purity, it is at last beginning to take a front rank as a wholesome and pleasant and desirable article. This experience in its manufacture and treatment has given such an impetus to the demand that the business is rapidly becoming an important enterprise to the State.

There seem to be few branches of business so profitable and so certain, as there has not been a failure of the crop within the thirty years grape culture has been an industry of the coast. Grapes are now raised and sold under contract to the wineries at a large profit and still leave a satisfactory profit to the manufacturer. The larger vineyards, however, have their own wineries, and thus reap the profit of raising and manufacturing. At the first glance it might seem probable that the business would be overdone, but the acreage of soil best adapted to grape-culture is limited; secondly, the aggregate is not ten per cent. of the loss of area in France from the destruction of the vines by insects. Sales appear to keep pace with the production, and it is rather to be regretted, as the quality of the wine would greatly improve with more age. Most of the production is sold within a few months of manufacture for cash, which is a temptation to the vineyards to realize from quick sales. In this early stage it is largely purchased for a base for the manufacture of other wines and shipped to the East and Europe.

California produces wines in great variety, among which may be mentioned hocks, sauternes, clarets, burgundies, madeiras, ports, sherries, muscat, and tokay—in fact all descriptions of dry and sweet wines. The ports, sherries, and burgundies are all heavy-bodied and as agreeable in flavor as the most expensive imported. Added to the wine production is that of raisins. In quality they are fully equal to the imported, and several of our leading hotels are adopting them. The exports last year was somewhere near 300,000 boxes, besides home consumption, which is considerable. It would seem that the time was coming when domestic wines will be extensively used, and the vineyards of California will reap the benefit. Already a large amount of capital is going into the business, which gives promise of great profit, combined as it is with fruit-raising, which until recently has not been profitable, simply because the supply was so far in excess of the demand; but the establishment of canneries and drying and shipping houses, with large capital, now absorbs the entire crop at good prices and profits to the producer, and we no longer see herds of swine luxuriating on the acres of peaches, apricots, pears, etc., as formerly. The smaller fruits of California are also a source of great profit to the producer, especially strawberries, which can be had in great abundance and comparatively cheap for eleven months of the twelve, and of course in such a climate fresh vegetables every month in the year.

THE CALCUTTA EXHIBITION.

A CORRESPONDENT of the New York *Times* says: It is somewhat singular that in this age of rapid transit and communication, when an occurrence of any social or commercial moment in the East is flashed half way round the world and through the medium of our enterprising dailies delivered at our very doors for our information and instruction, that so novel and striking a departure and enterprise as the International Exhibition to be held in the "City of Palaces" the coming cool season should have remained until the present comparatively unnoticed. No city in the East can claim an approach to the size, enterprise, and wealth of the Calcutta mercantile community. Nor in that quarter of the globe does its equal exist in a social or commercial sense. The seat of imperial and local government, the center of Eastern trade, into whose lap is poured the rich and accumulated products of Bengal, Assam, Pudh, and Orissa, admirably suited as it is in a commercial sense for an undertaking of this nature where the best results may, by enterprising exhibitors, be anticipated, its delightful climate at the season chosen for the exhibition in no less a degree recommends it to the notice and patronage of prospective visitors.

Many of the readers of this article who were fortunate enough to attend either of the exhibitions at London, Philadelphia, Vienna, Berlin, and Paris, or more recently at Sydney or Melbourne, will recall the delightful displays in the Indian sections of those exhibitions. The solid, rich staples of the Eastern empire, its magnificent and delicate fabrics; the inimitable traceries of Oriental art wares; the bountiful wealth of color and quality in the rugs, purdahs, and durrees; the jewelry and other ornaments, of unequaled design and workmanship, which arrested their attention and admiration, and which, for their more thorough enjoyment and appreciation, were again visited and revisited, yet these exhibits, however rich and gratifying to the ordinary traveler or casual visitor, afforded but a slender idea of the possibilities of an Indian exhibit unbarred and unfettered by the trammels of unenterprising Government officials, or the vaster hinderance of a journey of thousands of miles by sea over the Kali Pani—the dread of all Indian natives of whatever rank, religion, or caste. It is safe to say that in wealth, beauty, and magnificence of display no international exhibition before held will in any degree approach the Calcutta Exposition of 1883-84.

The Rajahs of the independent native States of Cashmere, Rajpootana, Nepaul, and Tipperah will contest with the various Nawabs of Southern and Central India for supremacy in the beauty and excellence of their local home arts and manufacturers, while the neighboring countries, Persia, Afghanistan, Bhutan, Sikhim, Burmah, and Siam, will display in a greater degree than ever before the variety of their national productions. China and Japan, too, will not be backward, nor will the Continental States, while doubtless England will be the largest and most extensive exhibitor. We have before us the prospectus of the Calcutta International Exhibition of 1883-84 (copies of which, with applications for space, may be had by addressing the Department of State), to be opened on the 4th of December next, and to be continued until the following March.

It is to be held under the distinguished patronage of his Excellency the Most Honorable the Viceroy and Govenor-General of India, K. G. P. C., G. M. S. I., G. M. I. E., while upon the list of members of the General Committee may be seen the names of such distinguished officials as his Excellency Gen. Sir Donald Stewart, Bart., G. C. B., C. I. E., Commander-in-Chief of her Majesty's forces in India; the Hon. Sir Richard Garth, K. T., Q. C., Chief-Justice of Bengal; the Right Rev. the Lord Bishop of Calcutta; the Hon. Major Baring, R. A., C. S. I., C. I. E. Following these are the names of nearly every Judge of the High Court of Bengal, the leading Government officials, the Consuls-General of the United States, France, Germany, Italy, Greece, Belgium, and the Netherlands, and the names of many of the principal merchants, while among the list of ancient and distinguished natives' names we notice the Hon. Maharajah Sir Jorndra Mohan Tagore, K. C. S. I.; his Highness the Rajah of Jhind, G. C. S. I., C. I. E.; the Hon. Rajah Shiva Prasud, of Benares, C. S. I.; Nawab Ali Kudr Synd Hussan Ali Bahudur, of Moorshedabab; Nawabi Abdool Gunny, C. S. I., of Daccen, and Rai Kristodas Pal Bahadur—a sufficient guarantee, European and native, of the class and tone of the undertaking. The magnificent and massive building of the Imperial Museum upon the main thoroughfare, Chowringhee, will be in a measure utilized for the exhibition, while temporary buildings for further accommodation are being erected upon the open maidan opposite.

The classification of the exhibits is as follows: Section A—Fine Arts; section B—Education and application of liberal arts; section C—Health; section D—Furniture and other objects of interior decoration; section E—Fabrics, including apparel, toilet requisites, and other objects of personal wear or use; section F—Raw products and manufactures from products not included in other sections; section G—Machinery and implements, means of transport, appliances and processes used in the common arts and industries, including models and designs; section H—Food products; section I—Agriculture and horticulture; section K—Ethnology, archæology, and natural history.

Gold, silver, or bronze medals and certificates will be awarded to exhibitors, by a special jury appointed for this purpose. And the provisional regulations for the government of exhibitors are of the most equitable and liberal nature.

A large influx of Americans, Australians, Europeans, and colonists in general is anticipated, and ample arrangements are being made for their comfortable accommodation, no less than for the anticipated native visitors from the various Presidencies, independent native States, and neighboring countries.

It is rather remarkable that the American manufacturers and merchants, with their proverbial push and enterprise, have, with few exceptions, up to the present day failed to penetrate with their wares, which in lesser countries have already gained supremacy, the bazaars of India. Here is a country of 250,000,000 of people, subjects of her Britannic Majesty (and it is safe to estimate an additional population of 100,000,000 or more residents of contiguous and interior States whose trade passes through and whose needs are supplied at the hands of British subjects). Their wants, it is true, differ widely from those of other nations, yet it is equally true that the wants of the better class natives of India are daily increasing, as shown in the increased imports from Europe and the Continent. Yet American products, save in the items of petroleum, cotton drilling, tobacco, and a few patent medicines, are rarely seen.

A walk through the bazaars of Calcutta, Bombay, Madras, Cawnpore, Lucknow, Benares, Delhi, Amritsur, and Lahore will disclose native shop upon shop devoted to the sale of English wares, tools, novelties, patent preparations, etc., but the eye of the American will fail to discover the familiar stamp of his home manufacture. The class of goods most in need and likely to meet with ready and increased sale are cotton and woolen goods of ordinary and low quality and price; tobacco, plain and fancy brands; cigarettes, tools, novelties, house-furnishing goods, native wines, patent medicines, proprietary articles, canned meats, vegetables, jams, and jellies. An exceptional opportunity is now afforded our enterprising manufacturers to gain a footing and permanent establishment in the vast markets of the Orient, and it will not stand well as testimony to their business acumen if they fail to seize and take advantage of it.

D. W. N.

[AMERICAN JOURNAL OF SCIENCE.]

THE EVOLUTION OF THE AMERICAN TROTTING HORSE.

By WILLIAM H. BREWER.

THE American trotting horse is an example of a new breed of animals in process of formation. As yet it can hardly be called a definite breed in which the special and distinctive character is either fully developed in quality or satisfactorily fixed by heredity. Great progress has, however, been made, many individual animals have attained great speed, and all the better ones have derived their trotting excellence in part, at least, through heredity.

The origin of most breeds is involved in considerable obscurity, as to how much they are due to conscious and how much to unconscious selection, what motives led to this selection, how far the enhancement of the special qualities has been due to physical environment and how far to education, training, nourishment, or cultivation. The formation of this new breed is so recent, the development of a special quality has been so marked, there is such an abundant literature pertaining to its history, the system of sporting "records" is so carefully planned and comprehensively conducted, and withal has become so extensive, that we have the data for a reasonably accurate determination of the influences at work which led to this new breed being made, the materials of which it is made, and the rate of progress of the special evolution.

It is as an implement of gambling and sport that the trotter has its chief value to the biological student. Sporting events are published or recorded as the mere every day use of animals is not, and the records of races give numerical data by which to measure the rate of progress. Similar data do not exist for the study of the evolution of any other breed.

Incidental to the preparation of a paper pertaining to this matter for farmers and breeders, I have compiled and collated certain data which have a scientific as well as economic value, the more interesting portion of which I condense for this paper.

The horse has several gaits which he uses naturally, that is, instinctively. And besides those which are natural he has been taught several artificial ones, some of which have been much used, particularly in the middle ages. But to trot fast was not natural to horses; when urged to speed they never assumed it, and until within a century the gait was neither cultivated nor wanted by any class of horsemen. A breed of fast trotters, had it been miraculously created, would doubtless soon have perished in that it would have had no use, satisfied no fancy, and found no place in either the social or industrial world as it then was.

Before the present century the chief and almost sole uses of the horse were as an implement of war, an instrument of sport and ceremony, an index of rank and wealth, and an article of luxury.

For all these uses, as then pursued, a fast trotter was not suited, nor was he better adapted to the heavy coaches over rough roads, or the slow wagon trains of armies. The horse best adapted to all these, however much he may have varied as to size, strength, and fleetness, was one whose fast gait was the gallop or run rather than the trot. For leisurely horseback traveling the ambling gait (or *pacing* gait, as it came to be called in this country) was preferred. With increasing use of horses for draught, certain heavy but slow breeds were developed in the Old World, of which the Dutch, Clydesdale, and Norman breeds are examples.

The causes which led to the cultivation of the trotting gait in this country and the evolution of a breed with which it should be instinctively the fast gait were various, and the separate value of each as a factor in the problem would be very differently estimated by different persons studying the subject from different points of view. Now that he is so valuable and plays such a part as a horse of use, it is easy to see why a breed of trotting roadsters should be produced to meet certain important demands of our modern civilization. But this does not explain how the process actually begun.

Reasoning *a priori*, the trotter, as a horse of use, should have originated in western Eprope; as a matter of fact, he not only did not begin there, but he was unpopular there until well developed here. Locomotives began to draw armies to the battle-field, the war-horse declined in actual as well as relative importance, the modern light, steel-spring, one-horse, convenient business wagon as well as the modern buggy came into common use after trotting as a sport was established and after the gait had been extensively cultivated and bred to. The trotting horse is especially adapted to various modern uses, but these uses followed his development, rather than led it, although in later days this factor has been an important one in the rate of progress.

The influences which originally led to the starting of the breed were more social than economical; a similar fact a century earlier marked the founding of that famous running breed, the English thoroughbred. The origin of the trotter, however, was not so simple as that, and several diverse social factors were involved, only the chief of which will here be noticed.

From early colonial times horses have been more generally owned by the masses of the people here than in any country of western Europe. They have had a more general use in agriculture and in business, their ownership or possession has had less social significance, and they have had less importance as instruments of gambling. The colonists who settled north of Delaware Bay, although of various nationalities, were largely those whose religious prejudices and social education were opposed to horse racing. With the great majority of them it was considered a sort of aristocratic sport and at best led to unthrifty ways, even if not open to the objection of positive immorality. Consequently but few race horses were imported into this region in colonial times. The original horse stock of the northern colonies came from several European sources. England, Holland, France, and Spain certainly, and Sweden, Denmark, Germany, Ireland, and Italy probably contributed to it. The blood from this variety of sources, variously mingled, formed the mongrel stock of the country. This was further modified by local conditions and local breeding assuming different characters in different places, and the hardships of horse life incident to a new country, with strange forage and a rough climate, caused deterioration in size and form. Early writers are unanimous on this point, but many add that what was lost in size and beauty was gained in hardiness and other useful qualities.

After the war of independence there was an improvement in the live stock of the country. English thoroughbred horses were imported both for sporting and to improve the horse stock of the country, and horse racing rapidly grew in favor as wealth and leisure increased. The export trade in horses to the West Indies increased, particularly from New England. Pacers were most sought for this trade, but sometimes trotters were advertised for.

As horse racing increased in the last years of the last century the opposition to it revived, and in the earlier years of the present century this became ascendant, and stringent laws forbidding the sport were passed in most of the Northern States. The prohibition was sweeping and the penalties severe.

Horse racing was then a contest between running horses, and during this repression of racing, trotting as a sport began, at first in a very unostentatious, irregular, and innocent sort of way. Probably no people or class of people have ever bred good horses which they prized and were proud of, who did not find pleasure in seeing them compete in speed or show their fleetness in some way, and during the repression of racing (which meant running), trotting came in as a substitute, poor though it was at first. It had a sort of encouragement from very many thrifty people who were not sportsmen, and was in a measure considered a sort of democratic sport in which even plow horses could take part. Racing of any kind in those days was a strife between two or more things, as it still is in most countries; no one thought that a single horse could run a race alone, but the instinctive inclination to see a spirited horse in action could be mildly gratified by letting him trot, even if single and alone, and testing by the watch how quickly a given distance could be covered. So "timing" animals came to be practiced. We hear of it on the Harlem race course in 1806, four years after the laws forbidding horse racing had been enacted, and again, a little later, near Boston, and it was reputed that certain horses could trot a mile in three minutes. This speed seemed so extraordinary that in 1818 a bet of a thousand dollars was staked (and lost) that no horse could be found that could trot a mile in three minutes. Some authorities date the beginning of trotting as a sport with this event. It is said that in betting the odds against the successful performance of the feat were great, which shows, strikingly, the enormous progress since made in developing speed at this gait.

In 1821, certain persons on Long Island were allowed by special statute to train, trot, etc., horses on a certain track, under certain restrictions, exempt from the penalties against horse racing. Other organizations followed, and by 1830 the "training" of trotters was going on at several points, and trotting may be said to have become established as a sport. During this decade the record had been successively lowered to 2:40, 2:34, and 2:32. The times of performance were carefully taken at these "trials of speed," as the statute called them, and "records" became established by more formal sporting codes.

The ostensible object of these associations was the "improvement of the breed of roadsters;" driving single horses to wagons became fashionable, and this led to the improvement of light one-horse wagons for business and pleasure. Those with steel springs were rare luxuries in 1830; by 1843, when the record of mile heats dropped to below 2:30, they were already common. During this thirteen years, the record had been lowered only half a second on mile heats, but three minute horses were no longer rare.

The fashion of wealthy men driving a single fast trotter for pleasure was for a long time a peculiarly American one, and played an important part in the development of this breed. But, as stated earlier, many influences have contributed; changes in the modes of travel, changes in the methods of war, sentiments regarding horse racing, the incentives of the course, the general improvement of roads, improvement in carriages, the needs of modern business requiring quick roadsters, these and other influences have all been at work.*

The material out of which this new breed is made is a liberal infusion of English thoroughbred blood (usually more than two generations removed) with the mongrel country stock, previously described. There is a voluminous literature relating to special pedigrees, and much speculation as to the comparative merits of the several ingredients of this composite blood.

The gain in speed is given in the following table, which is the best records at mile heats, omitting the names of the special performers:

Date.	Best Record.	Date.	Best Record.
1818	3·	1865	2·18¼
1824	2·40	1866	2·18
"	2·34	1867	2·17¼
1830	2·32	1871	2·17
1834	2·31½	1872	2·16¾
1843	2·28	1874	2·14
1844	2·26½	1878	2·13¼
1852	2·26	1879	2·12¾
1853	2·25½	1880	2·10¾
1856	2·24½	1881	2.10¼
1859	2·19¾		

A sporting paper published in 1873 a list of three hundred and twenty-three horses, with their best records, down to the close of the preceding year. This first list of the kind known to me was very imperfect in its details; it was revised for the next year, and since that time many lists, in one form or another, have been published. The figures for the animals with records of 2.25, or better, are reasonably accurate; for the others there is much discrepancy.

In the following table the numbers are my own, counting down to 1872, inclusive; the numbers after that date are derived from various lists published since that time in the sporting and breeding periodicals. From the very nature of the case, the table cannot be accurate in the larger numbers, but the numbers do not lose their value for comparison with each other from such faults as to the details of the larger numbers, and as such it is undoubtedly the most significant series of numbers ever compiled to show progress in evolution, whether of a breed or species. The number of horses with records of 2.40, or better, is now stated to be over five thousand.

I leave it to mathematicians to plot the curves which immediately suggest themselves, and determine how fast horses will ultimately trot and when this maximum will be reached.

TABLE SHOWING THE NUMBERS OF HORSES UNDER THE RESPECTIVE RECORDS.

	2:30 or better.	2:27 or better.	2:25 or better.	2:23 or better.	2:21 or better.	2:19 or better.	2:17 or better.	2:15 or better.	2:13 or better.	2:11 or better.
1843	1									
1844	2	1								
1849	7	2								
1852	10	3								
1853	14	5								
1854	16	6								
1855	19	6								
1856	24	7	1							
1857	26	7	2							
1858	30	7	2							
1859	32	9	2	1	1					
1860	40	11	4	2	1					
1861	48	14	4	2	1					
1862	54	17	7	4	1					
1863	59	19	9	4	1					
1864	66	22	12	4	1					
1865	84	29	15	5	2	1				
1866	101	32	17	6	3	1				
1867	124	42	21	9	5	2				
1868	146	52	28	13	6	2				
1869	171	63	34	15	10	4				
1870	194	72	35	16	11	5				
1871	233	99	40	17	12	6	1			
1872	323	- -	- -	- -	- -	- -	- -			
1873	376	- -	74	28	15	5	3			
1874	506	- -	98	40	16	11	5	1		
1875	- -	- -	134	61	30	13	5	2		
1876	794	- -	165	81	39	16	6	2		
1877	836	- -	214	105	51	19	8	2		
1878	1,025	- -	270	129	68	24	9	4		
1879	1,142	- -	325	164	88	33	11	5	1	
1880	1,210	- -	366	192	106	41	14	6	2	1
1881	1,532	- -	419	227	126	49	15	7	2	1
1882	1,684	- -	495	275	156	60	18	8	2	1

* For more details regarding the history of this development, and the factors involved, see the paper already cited, Rep. Conn. Bd. Agr. for 1882, p. 215.

A NEW LUMBRICUS.

NEW—not in the sense that it has never before been seen by human eyes—not that it has escaped classified description—but new in the way Mr. Darwin has presented the whole family of earthworms; and new in a location heretofore unheard of—peculiarly adapted to its extraordinary development.

Running through the States of Alabama and Mississippi, southeastwardly, from a point between Vicksburg and Yazoo City, as yet undetermined, is a region of marine origin, mostly calcareous, and belonging properly to the middle tertiary of the Gulf States, known locally as the Southern Prairie belt. To a general observer it consists of a chain of small prairies of wonderful fertility, surrounded by or bordered on two sides by sandy hills and plains covered with pine. A paradise to modern farmers. In the rich, lime lands he has a soil equal to any in the world; and in the poor piny woods he has health and elbow room to satisfy a Daniel Boone. The perfection of this favored, unknown land may be seen on the creeks, Pachuta and Shubuta, in the Counties of Jasper and Clarke, Mississippi.

Now these bounteous prairies are generally low lying, and have been forced to give waterway to the mill streams descending from the perpetual springs of the sand hills. There are hills also of the prairie lands, and sometimes these get washed off *bald*, as the expression here is—that is, without vegetation and without soil. Except these bald points the soil is very black—a tenacious clay vegetal loam, and singularly uniform in thickness. Except, again, where there has been some detritus accumulating, the depth of the loam is about two feet; scarcely less on the highest hammock land; scarcely more on the most level prairie.

Now, what keeps this soil rich? and what renews its fertility when given rest, and protected from washing, and stock?

Strange as it may sound to the ears of farmers of the chemical school and closet practice, the producer of all this black loam is a gigantic earthworm.

Earthworms are common everywhere, especially so in all calcareous prairies; but nowhere quite so large as these—nowhere so abundant. A foot in length, and the diameter of a large turkey quill is common. But what will you say to double these dimensions, and not uncommon?

The manner of work of these earthworms does not differ from that of their kind, but the effects are scarcely paralleled. In a field long undisturbed all over the surface appear little hillocks of excrements, as if rats had been about. You look around for hole or hiding place of small animals; none are to be seen. Except these hillocks, rising one, two, or even three inches, nothing disturbs the uniformity of the ground. At length they become so numerous as to touch at their base. Still no sign of opening or hole anywhere. Animal debris these little mounds undoubtedly must be, and in quantities too great to have been left by visiting rats, or mice, or beetles. You investigate, and near the middle of every pile, when removed, you find a shaft piercing the earth quarter of an inch to half an inch in diameter. Dig, and you will be tired of the task before you unearth the tenant. Unlike his cousin, the humble red worm, used for fish bait, he seems to want the habit of crawling out when the ground is disturbed. This one contracts his rings and draws himself down into the hard subsoil.

One result of the labor of our lumbricus evidently is to bring up from beneath the alkaline clay, and to spread it over and bury under it grass and other matters on the surface. It is also in a finely comminuted form—readily yielding to the action of sun, and air, and frost. Nor does his work stop at this covering process. He takes what amounts to large quantities of herbage below for food and for lining to his cave. Considering their vast numbers, the turning under of green crops must aggregate tons in a season.

Nor is foliage of grass and weeds all that is buried. Shells and pebbles also disappear from the top of the ground. The natural, undisturbed prairies are rich in land shells. The wet portions even have some fresh water forms; but in the early spring it is difficult to find one alive. At times thousands of these shells—Helix, Blandina, Succinea, Pupa, Melania, and even Paludina—cover the ground. Yet these are a handful to the myriads that sleep beneath the surface. All the way down from the top to the bottom clay this prairie mould is filled with them. At the bottom is a seam an inch thick or so composed of the shells in all stages of decomposition. Particularly numerous amongst them are the minute forms of Succinea and Pupa.

In the new, undisturbed prairies the earthworms are inconceivably numerous. The natural American Fauna had for them comparatively few enemies. Most destructive to them were the original inhabitants. The Indian women prepared a dish from them which, it is said, they once relished exceedingly. But it must have been slow work for the squaws, with their scratch sticks, to have procured enough for one day's rations. Not until civilization brought the turning plow to the prairie, had our great Lumbricus cause to dread his lordly fellow worm. And it brought poor Lumbricus another European colonist from which he may well fear extinction—the hogs. It is a sight to see in the early spring, where hogs have access to prairie lands. They plow it up, and mix it up, and heap it up—raising head only to champ the great worms which wreathe around their snouts like serpents.

Geologists ought to bear these worms a grudge. They have caused bewildered science a deal of trouble. Looking upon the fact that a foot or so below the surface were always found many land shells and in a few places some fresh water marsh shells also, some of the early students of the science came to the conclusion that the prairies were originally fresh water ponds and swamps. A practical joke Mr. Lumbricus has played upon the 'doctors who would peep and botanize upon a mother's grave.' . . . In a similar way, whenever let alone, these earthworms in time make fresh water formations on the top of the highest calcareous hills. The mollusks—their fellows in the deceit—are also very interesting, and deserve special study.

SETTLING SWALLOWS.

ABOUT 7:30 o'clock last evening residents in the vicinity of Farnam's Mill, Ida Hill, witnessed an unusual and interesting spectacle. The tall stack of the mill looms upward over the building to a height of 70 or 80 feet. For several years past flocks of swallows have been accustomed to pass the night in the stack. Their numbers constantly increased, and last fall many people gathered nightly to witness the settling of the birds. The swallows made their first appearance this spring Thursday evening. They came in flocks of tens and twenties, and quietly entered the opening in the chimney. Last evening residents in the neighborhood and passers by were surprised to see thousands of swallows approaching from all parts of the heavens. Their numbers were greatly augmented until it is estimated that 7,000 or 8,000 birds were flying about. Shortly the immense flock arose to a height of several hundred feet and circled about, flying faster and faster, so thick that they appeared one moving and impenetrable mass. Suddenly the birds in the center shot downward to the chimney, the feathered mass assuming a funnel shape. The birds then dropped quickly into the stack, seemingly in sections. After a portion of the flock had disappeared, the other birds near the top of the stack remained for a time suspended, evidently to permit the settling of the birds within the stack, and then another section disappeared into the opening. While circling in the air the birds made a loud chirping noise that could be heard blocks away.—*Troy Telegram.*

CULTURE OF SMALL FRUITS.

THE discussions at a recent meeting of the Massachusetts Horticultural Society, as reported by Robert Manning, the secretary, gave the experience of several distinguished cultivators. Benjamin G. Smith had greatly improved his heavy garden soil by carting on two hundred loads from a small locality of sand, and rendered the growth of gooseberries and currents quite successful—a course which we adopted twenty-five years ago with undiminished successful results down to the present time. He prunes these berries as carefully as he does grapevines, the spur and the long shoot system being equally successful. He cultivates the same bushes which he had fifteen years ago.

John B. Moore had found that blackberries must be grown on upland without manure to cause the wood to ripen and to prevent winter killing. He prefers the Sanders raspberry to the Herstine. He plants in rows six feet apart, and stretches a galvanized wire over the rows to a post at each end. The canes are tied with cotton twine six inches apart along this wire. He cultivates with horse power. The canes are easily laid down in autumn, by beginning at one end, throwing a shovel of earth against the first canes to bend them over, and all are then bent down and held with earth from one end to the other. They must be carefully uncovered in spring as soon as the ground is thawed.

E. W. Wood said currents must be well fed, but blackberries and raspberries need much less manure. He saw an immense crop of Dorchester blackberries at Weston, in rows eight feet apart, tied to wires four feet from the ground, and the plants topped at six feet high. They were mulched with meadow hay, and covered with it in winter. He found the Kittatinny hardier than the Dorchester. W. H. Hills, of New Hampshire said he did not tie up red raspberries, but clipped them when three feet high, and blackberries a little higher. The Turner raspberry and Snyder blackberry proved perfectly hardy. Col. Wilder said Mr. Hills' clipping caused laterals and made tender bushes into hardy ones. If he could have but one raspberry, it would be Souchetti Blanc. He said the imposition practiced by exaggerated descriptions of new fruits was a national evil.

W. C. Story had found Taylor's Prolific blackberry as hardy as Snyder's, and it gave a profusion of fruit. He clipped the top with an old scythe blade set in a handle. Nearly all the speakers spoke highly of the Franconia raspberry as one of the best sorts.

NEW BUILDING FOR THE VICTORIA REGIA IN THE BERLIN BOTANICAL GARDEN.

THE main object in view in establishing a botanical garden should always be giving the public an opportunity of acquiring a knowledge of the various domestic and foreign plants, flowers, shrubs, etc. In this respect the botanical gardens of some of the larger European capitals, for instance in London, Paris, Berlin, etc., meet all requirements, and are visited by hundreds in search of information and knowledge. The Botanical Garden in Berlin was visited by few persons only in former years, but of late a vast number of people of all classes assembled there, especially at the time of the blooming of the Victoria Regia, of the Nymphæceæ family, to which the ordinary white and yellow water lilies and the well known Egyptian lotus flower belong. The Victoria Regia was discovered in 1801 by Hänke in one of the branches of the Amazon. It has several names—Euryale Amazonica, Nymphæa Victoria, and Victoria Regia, the latter in honor of the Queen of England being the most popular. In 1849 a Victoria Regia, queen of the water plants, was brought to bloom for the first time on European ground at Kew, near London, and since 1852 blooming Victoria Regias have been exhibited in the Berlin Botanical Garden every year. It is so difficult to raise and keep these peculiar plants in our climate that only very large institutions can raise them. As a child of the tropics, it requires much heat, light, and air, and in order to supply the plants at Berlin with a sufficient quantity of the above necessities of life, the directors of the Botanical Garden have erected a new building, which we show in the accompanying cut. It is built of glass and iron, and has the shape of a regular decahedron 49 ft. in diameter, with a basin or tank 29 ft. in diameter and 1 ft. 3 in. in depth. In January, the seeds, which are about the size of a pea, are sown; that is, they are soaked in water from eight to fourteen days, and are then planted in small pots in which they are kept moist and are protected by glass shades or globes. The young plants are transplanted into the large basin at about the middle of April, in the middle of which basin a small mound or hill of earth is formed, in which the roots are embedded. The water in the tank must have a temperature of from 20° to 25° R. (77° to 88° F.). The plants grow very rapidly as soon as they begin to bloom, and it has been observed that some stems have grown from four to sixteen inches in four hours, and in the same proportion the circular leaves grow, which finally attain a diameter of about 8 ft. 8 in. The leaves have a light green, smooth upper surface, whereas the lower surface is provided with longitudinal and transverse ribs provided with reddish bristles. The edges of the leaves are bent upward, and the veins of the leaves contain air, and thus the leaves are adapted to support a considerable load. The crown of the flower is wonderfully beautiful. By about the middle of July the first bud appears, which opens at precisely four o'clock in the afternoon into a beautiful white flower, tinted pink in the middle, and of wonderful fragrance. It increases toward twilight, and at midnight it has attained its greatest beauty. After midnight it begins to close, and is entirely closed by four o'clock the next afternoon. Each flower opens twice and then dies. In this manner from ten to fifteen flowers bloom. The fruit, which attains a size of about eight inches in diameter, contains numerous seeds of the size of a pea. A peculiarity about this flower is that by the sudden growth much heat is created in the interior of the flower, so that the thermometer shows a temperature from 8° to 12° R. (50° to 59° F.) higher in the middle of the flower than in the surrounding air. Besides the Victoria Regia, several other like plants, such as the lotus, papyrus, and others, are contained in the new building.—*Illustrite Zeitung.*

JUNIPERUS RECURVA.

THIS is the "weeping blue juniper" of the Himalayas. It is a shrub in some places, a low tree in others, with recurved, drooping branches and sharp, needle-like leaves arranged in worls of three. The berries are oblong or ovoid, about half

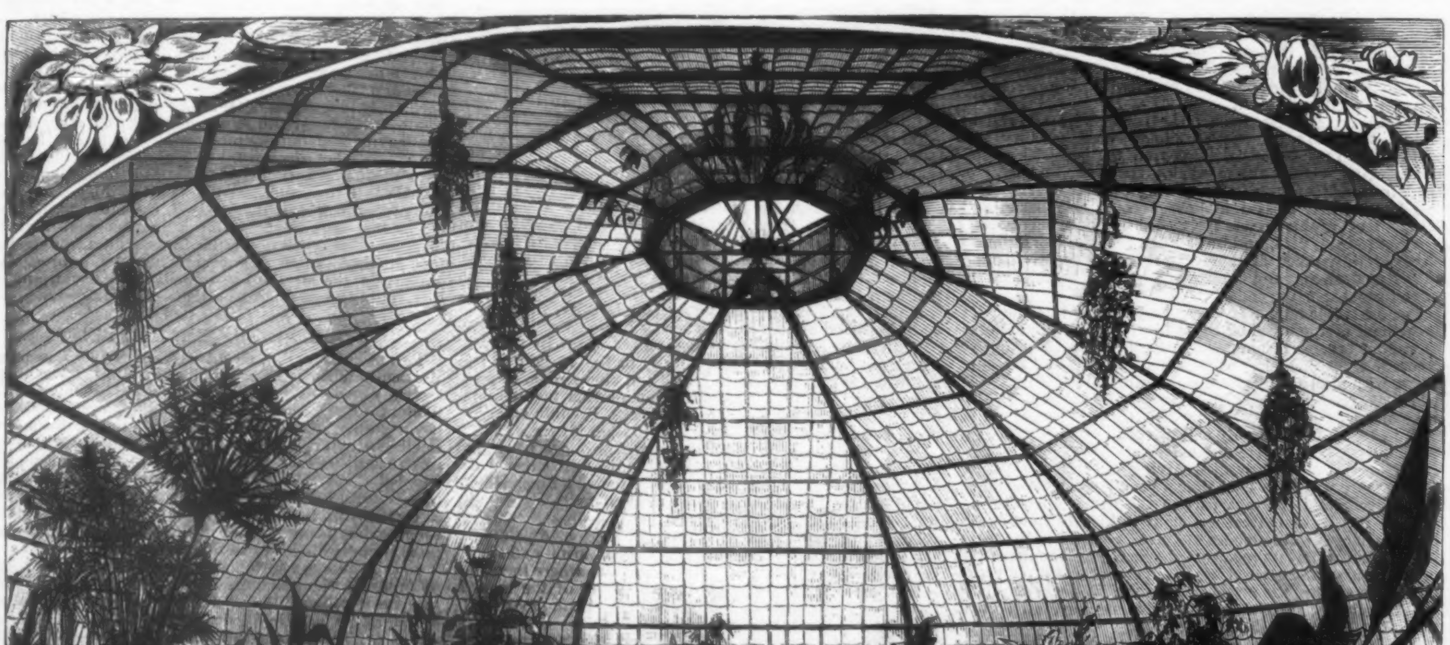
JUNIPERUS RECURVA, FEMALE PLANT. FRUITS AND SECTIONS MAGNIFIED.

an inch long. In the vicinity of the temples in Sikkim it was noted by Sir J. D. Hooker to form a tree 30 feet high, with a pyramidal crown. In the Northwest Himalaya, according to Brandis, it is a prostrate shrub, covering large areas, and by its prickly foliage and dense mass of branches rendering walking difficult. The bark is cinnamon-colored, flaking off in thin recurved flakes. The wood is reddish-brown, fragrant, like that of the pencil cedar. Brandis tells us that coarse barley flour is made into balls, covered with the sprays and leaves of this plant. The balls are wrapped in blankets and kept warm for three to four days, till fermentation is set up, when they are used in the distillation of arrack from rice. A woodcut showing the tree-like form is given in Hooker's *Himalayan Journals*, vol. ii. (1854), p. 45. The plant is hardy in this country, where it forms a shrub of striking habit, but with dull, sickly-looking leaves. Both Gordon in the *Pinetum* and Messrs. Veitch in their *Manual of Conifers* remark that the male is denser, dwarfer, and with looser foliage than the female form, which is more open, with more pendulous branches and more appressed leaves. We have not seen the male form.—*The Gardeners' Chronicle.*

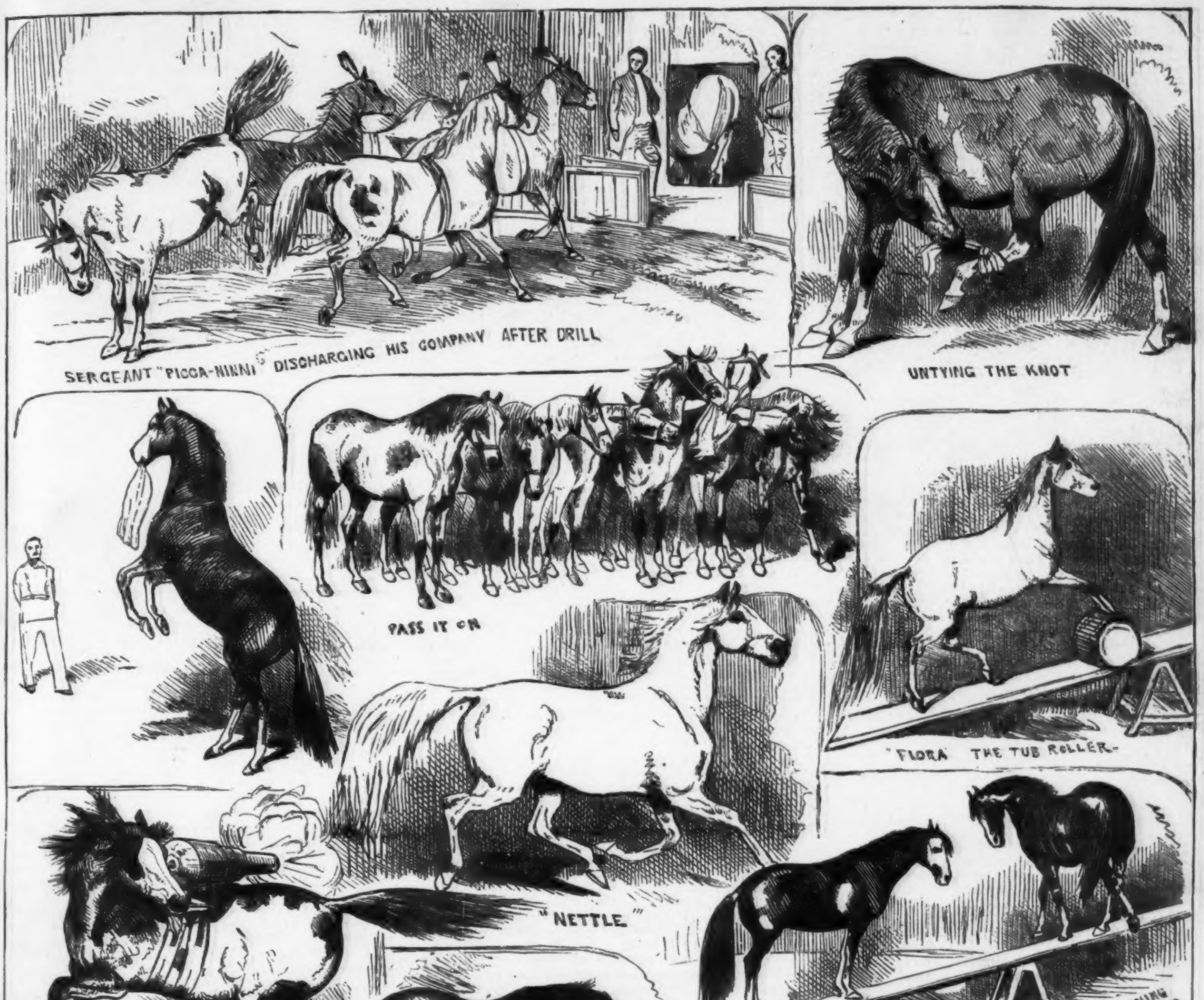
WILD HORSES IN LONDON.

THE visitors to the Westminster Royal Aquarium have lately found its programme of entertainments greatly improved by the exhibition of an American team of performing horses, under the direction of Mr. Robert White, who is said to have caught them wild on the prairies of Colorado, and to have broken them in and trained them, with marvelous skill and address, during the last five years. They are, we learn, of the "Broncho" breed, which may have figured in descriptive books of travel or natural history more often than we can just now recollect; but they are certainly a very fine variety of the equine species, reared in a country and climate most favorable to the development of the native powers of this noble animal; and their feats are most surprising, even when compared with those with which we have long been been familiar in the ring at more than one famous establishment, since Astley's original commencement a hundred years ago. The whole troop, without any riders, obeying the mere word of command, following the leadership of a mare named Piccaninni, who is humorously styled the sergeant, will go through a series of military evolutions, marching, wheeling, charging, retreating, and counter marching, with as much precision as if they were ridden by regular cavalry soldiers in a barrack-yard. Piccaninni, too, is a clever and amusing sole performer, dancing, walking on her hind legs, and carrying a handkerchief in her mouth with the most ladylike ease and grace; while Bravo and Bonito can open a box, take out some article, and close the box again, besides playing leapfrog with each other, or using a board, like two sportive boys, for the enjoyment of see-saw. It is pretty to see the whole company, six or eight of them, standing in a line close together, and passing a handkerchief from one to another by their mouths with the most charming gentleness and politeness of manner. Then we admire the docility of Kitty, as she jumps backward and forward over a gate, or distinguishes flags of different colors, known to her by name, like the most intelligent of trained dogs, or leaps courageously through a hoop covered with burning paper. Another horse, the martial Cupid, by a movement of his head fires a small cannon placed on his back, while in the act of leaping; and Flora, using her fore-feet like hands, trundles a barrel up and down an inclined plane. The most wonderful leaping horse is Nettle, who clears at a bound the backs of four others, besides a gate or fence six feet high. "What can be done with wild horses!" It is, indeed, worth while to go and see.—*Illustrated London News.*

ALTHOUGH three or four crystals of the genuine precious topaz, remarkable for size and clearness, have been found near Pike's Peak, Mr. R. T. Cross asserts that the stone which is cut in Colorado, and sold as topaz to tourists, is not topaz at all, but simply smoky quartz, or the cairngorm stone of Scotland.



NEW BUILDING FOR THE VICTORIA REGIA IN THE BERLIN BOTANICAL GARDEN.



EDUCATED AMERICAN HORSES IN LONDON.

ANNUAL REPORT OF THE STATE GEOLOGIST OF NEW JERSEY.

THE Annual Report of the State Geologist of New Jersey for 1882, which has only recently been published, embraces communications upon a variety of subjects connected with the progress of the survey of that State. The report consists of thirteen divisions or parts, nearly every one of which contains information interesting to the general public, and of especial consequence to the intelligent residents of New Jersey.

In the first article it is announced that the U. S. Coast and Geodetic Survey have made very satisfactory progress in determining the latitudes and longitudes of conspicuous points in different sections of the State, and by next spring (1883) it is hoped that 5,326 square miles or nearly three quarters of the State will have been surveyed, the whole State comprising 7,576 square miles. The Topographical Corps has been employed upon the survey of the northern portions of the Highlands and the unfinished portions of Bergen County. It is a difficult region, and progress has been slow. The whole area covered by the survey up to the present time is 1,740 square miles. Of the work of preceding years, amounting to 1,260 square miles, 847 square miles are included in the map published this year, and 413 square miles are mapped ready for the engraver.

The levels of the New Jersey survey, previously referred to mean tide at Newark, are now connected with those of the U. S. Coast and Geodetic Survey, and henceforth elevations will be referred to mean sea level at Sandy Hook.

The third part of the report deals with geological work in progress and opens with a description and discussion of the famous Red Sandstone district. The red or Triassic sandstone is by no means limited to New Jersey. It extends north and south from Massachusetts through Connecticut, New York, New Jersey, Pennsylvania, Maryland, Virginia, and North Carolina in a generally northeasterly and southwesterly direction, while a detached area is found in Nova Scotia. It presents everywhere a remarkable uniformity in its physical characteristics and affords at numerous points the well-known brownstone used in building. For a long time, as even to-day, its exact geological position remained doubtful, the almost complete absence of fossils in its beds making it difficult to determine its age. In 1839, Profs. W. B. and H. D. Rogers demonstrated that it was younger than the coal measures, and later Hitchcock and Redfield showed it to be older than the Jurassic, and Lyell subsequently adduced evidence to prove that at least its upper portions should be referred to the Jurassic. Fossils are needed, and the Survey invites residents of New Jersey to assist them by their collections wherever possible.

The red sandstone formation extends from the Rockland County line on the northeast to the Delaware River as far as represented in New Jersey. This is a distance of about 70 miles; it increases in width as the observer traverses it from the New York line to the Delaware, covering in all 1,507 square miles. It is in general a plain with broken and irregular outlines on the north and northwest, where it meets the headlands and projections of the Highlands and the adjacent intermediate outcrops of limestone, and is lost on the east and southeast, under the Cretaceous clays and later sands, being bounded as well for a short distance to the north by the waters of the Hudson River and New York Bay. The ancient ridge of gneissic and archæan rock, which probably extended along the southern border of the trough in which the Triassic now lies, is buried under more recent deposits, but reappears at Trenton in a wedge-shaped outcrop, separating the sandstone from the clay beds on the south. This gneissic outcrop belongs to the gneissic ledges of New York Island, the intermediate areas having been degraded by disintegration and denudation and subsequently hidden by later beds. The rocks of the red sandstone formation are shales, sandstones, silicious conglomerates, calcareous conglomerates, limestones, and the intrusive trap-rocks.

The red shales and sandstones are the predominating constituents and form large areas, while they prevail almost universally in the drift material derived from this formation. The shales vary greatly in hardness, including scarcely compacted clays to argillaceous sandstones. The softest beds show lamination and split readily along the lines of bedding. The softer varieties fall to pieces on exposure to the air and make the red clay soils so characteristic of portions of New Jersey. They are of various compositions, being classed as "bituminous shales, impure calcareous shales, besides the various grades of arenaceous or sandy shales."

The sandstones of this formation present a great diversity of characters, not only in composition but in their physical properties, as color, hardness, endurance, and solidity. The most common sort is an argillaceous sandstone which breaks easily with the hammer and soon falls to pieces on exposure to frosts and atmospheric influences. It has no value as a building stone. But in many instances this poor material is interstratified with good building stone. The sandstone generally varies remarkably in its fineness of grain. Some exposures show a dense, compact mass in which the grains are scarcely distinguished by the naked eye, while in other places it is "a cemented mixture of quartz and feldspar in slightly rounded or even angular fragments," as at the foot of the Palisades, and yet again it is so slightly held together that it crumbles in the hand, as at Trenton. Quartz is the principal component, the silica reaching 88 per cent.; feldspar occurs plentifully in it, and mica scales frequently, but in inconsiderable quantities. It is a favorite building stone and quarries abound throughout the belt in which it is found.

The conglomerates are of two kinds, silicious and calcareous; the silicious holds quartz pebbles occasionally associated with gneiss, granite, sandstone, slate, and limestone nodules. The calcareous variety occurs on the northern border near Pompton in Passaic County, in Hunterdon County, and near Clinton. It is blue limestone pebbles occur. It is used in making lime. The limestone occurs in very thin beds and forms a very inconspicuous member of the red sandstone formation. The trap-rocks compose the last series of rocks forming this area, and are notable for the striking scenic features they form as well as for their mode of origin. They are extended masses of lava thrown out between and through the sandstone layers, forming long ridges, dikes, and prominent elevations. They have resisted erosion on account of their greater hardness, and hence stand out above the shorter shales and sandstones. Their extent is limited, amounting to 190 square miles or about one-seventh of that of the other rocks of this formation.

The principal ranges are First and Second Watchung Mountains, the Palisades, and Sourland Mountain. These follow the general trend of the sandstone area from northeast to southwest, exhibiting westerly flexures at their southern terminations, giving these ends a scythe-like curvature. The map accompanying the report shows the numerous outcrops of the trap-rock, many having isolated hummocks and a few characterized by sigmoidal bends in their surface outlines. The range of trap-rock known as Palisade Mountain extends from the Highlands west of Haverstraw in New York, attaining an elevation of 1,000 feet in the High Torn Mountain, to the Fresh Kills on Staten Island, forming the mural escarpment of the Palisades and Bergen Mountain. The Palisades reach a maximum height of 547 feet near the borders of New Jersey and New York. The sandstone can be seen underlying the trap as well as the subadjacent shales at Weehawken. The columnar structure of the trap, so familiar in the pentagonal columns from the Giant's Causeway, Ireland, is exhibited near the State line. The rock is remarkably fine grained, is an excellent quarrying stone for pavements, and breaks well in all directions. "The rocks of the First and Second Mountains (commonly known as the Orange Hills) are mostly fine-grained, compact, and tough, and grayish to dark-blue in color, apparently dolerites like the Bergen Hill rock. In some of the outcrops on the upper surface the amygdaloid structure is observed; also the cellular has been recognized. The latter is evidence of cooling without pressure, as if the outflow had passed beyond the shale strata. The great changes which the shale has undergone near the trap-rock, as seen in the copper mines of these ranges, is evidence of the subsequent outburst of the igneous rock and coming out through the parted shale and sandstone strata. The copper ores appear to have had their origin about the same time, as they are confined to a narrow belt of few feet in width at the plane of contact."

The structural peculiarities of the sand-rock have elicited a number of explanations. Its strata in New Jersey very generally dip to the northwest, as they also do in Pennsylvania with the more westerly ones of Maryland, Virginia, and North Carolina. The red sandstone in Massachusetts, Connecticut, east Virginia, and North Carolina dips toward the southeast. This leads to the remarkable conclusion that the strata in New Jersey are not less than 2,500 feet thick. The rocks are but slightly faulted, without flexures or conspicuous disturbance or fracture. Prof. Rogers originally considered that the whole Triassic formation from North Carolina to New York lay in an estuarine trough, the bed of a broad stream that poured northward and formed this extraordinary flooring of sand, which afterward, consolidated and cemented together, became the Triassic sand-rock. Later it has been assumed by others, notably by I. C. Russell, that the Triassic areas of Connecticut were originally connected with those of New Jersey and that the intervening tract of sandstone beds has been removed by a denudation of a stupendous and monumental character. Objections strong enough to warrant the rejection of these theories of the structure and relations of the sandstone layers have been made, and Prof. Cook offers an hypothesis upon which the Survey are inclined to rest, viz.: "That after their deposition on a very uneven bottom, the underlying rock has been disturbed by a number of axes of elevation or else of great faults, which have crossed the formation obliquely, but in a direction much nearer north and south than the general trend of the formation. The Hudson River and the country east of it toward the Connecticut represent one or more of these. The axis which crosses the Delaware at Lambertville, and in which the magnesian limestone is now exposed in Pennsylvania, and the lower coarse white sandstone in New Jersey is another; and the long line of exposure of the Triassic in Virginia in a nearly north and south line, south of the Potomac, shows the direction and extent of another of these; and numerous smaller ones can be traced out. The elevation of these axes would give a general dip of west-northwest on one side and east-southeast on the other, but not at right angles to the trend of the formation, and it would not require so great a thickness for the whole mass as has been generally computed."

After this period of elevation the trap eruptions followed, and their denudation removed the sandstone upon and around them, leaving their more resistant masses in bold and almost mountainous relief. Very extended and detailed descriptions of the numerous trap extensions are embodied in this portion of the report.

The iron mines of New Jersey are reported to be as productive as in previous years. The output for 1882 amounts to 900,000 tons, an excess of 140,000 over that for 1881, and larger than previous years. Much foreign ore has been imported which, from its freedom from phosphorus, is well adapted for making Bessemer steel. The amount of phosphorus in many of the New Jersey ores prevents the successful use of these in this manufacture. Ores low in phosphorus are found in the Green Pond and Chester ranges and among the mines of the Pequest belt. A few mines have been abandoned on account of the expense attending extraction of the ore, which had to be mined at considerable depths, 1,100 feet on the slope. New openings have been made and trial pits and prospecting have shown in many places the existence of paying bodies of ore. It is hoped by the Survey to be soon possible to present a map of the iron region, and to accompany it with a discussion of the economic and geological questions it raises.

The plastic clays of New Jersey maintain their celebrity, and the yield surpasses that of previous years. Those of Middlesex County have been greatly developed, the nearness of the banks to water transportation affording unusual advantages to shippers. One of the remarkable developments connected with this portion of New Jersey's resources and the pottery industry is the increasing attention paid to terra cotta manufacture. Friezes, wall decoration, architectural designs, are made of this terra cotta, which supplies at a very small cost the more expensive cut stones. The friezes of the Grammercy Park Hotel in this city are made in this way, deep brown as well as red and buff colors being made.

The Terra Cotta Lumber Company, two and a half miles west of Perth Amboy, produce a singular product. Clays, free from coarse sand and highly plastic, are mixed with spruce sawdust in the proportion of three of sawdust to two of clay. The ingredients are mixed in pits by wheels armed with rotating knives. Little water is used. After thorough union has been effected, the clay mass is taken and pressed by steam-press in rectangular shapes, which are slit and cut into the ordinary forms required. These are then dried by artificial heat and afterward burnt. The time for burning varies from thirty-six to forty-five hours. Each kiln will hold about 30 tons of blocks or tiles. "The product from the kilns has several valuable properties. It is fireproof; it is light, weighing only 58 to 62 pounds per cubic foot, or scarcely more than half as much as common brick; it is equally strong in all directions, resisting crushing strains in hard-made cubes, two to five and a quarter inches on a side, of 1,835 to 13,037 pounds, varying somewhat according to their sizes and the composition or proportions of sawdust to clay; it can be sawed or planed into desired shapes almost as easily as wood, and holds nails, and is used in place of wood; and it is not affected by coal gases as mortar, nor a good conductor of heat as iron or the metals." It sells readily, and prices vary from $12 to $18 per ton.

A chapter on shore changes exhibits the gradual encroachments of the sea upon the shores of New Jersey, as well as slight recoveries of the latter. An action which is quite prevalent is the drifting landward of sand, which then covers up marsh lands, heath meadows, and fields, and these are again displayed when heavy storms wash back the sand or partially remove it. Tracks uncovered in this way are supposed to have been made as long ago as 1690, while at the same point the shore has receded, since 1839, 310 yards.

The report dwells with evident satisfaction upon the enormous increase of seaside resorts in New Jersey and the consequent improved revenue of the State; fifty-two of these are enumerated, a very important feature in the State's development. It may not be generally known that the climate of southern New Jersey is attractive for its uniformity and temperate character, verging, as the report expresses it, upon a sub-tropical character. The mean winter temperature of Cape May is 36° Fahrenheit. The season for growing vegetables is from two weeks to a month longer in southern New Jersey than toward the north around New York.

Cattle winter on the sea-board with little care or shelter. Cotton, tobacco, sugar cane, sorghum, grow upon the soil of southern New Jersey under the stimulus of proper fertilization; and the crops more characteristic of the State, as sweet potatoes, market vegetables, and fruit, yield the most flattering returns. The fruit-yielding centers are at Hammonton, Egg Harbor, and Vineland. From Hammonton alone in 1879 there were shipped 746,404 quarts of berries, 1,600 bushels of pears, and 1,000 barrels of sweet potatoes. Grapes thrive and wine is manufactured in very considerable quantities.

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